Check for updates

Regular Article

Hammill Institute on Disabilities

Journal of Learning Disabilities
46(3) 260–277
© Hammill Institute on Disabilities 2011
Reprints and permission:
sagepub.com/journalsPermissions.nav
DOI: 10.1177/0022219411420571
journaloflearningdisabilities.sagepub.com
SAGE

The Effects and Interactions of Student, Teacher, and Setting Variables on Reading Outcomes for Kindergarteners Receiving Supplemental Reading Intervention

Shanna Hagan-Burke, PhD[1], Michael D. Coyne, PhD[2], Oi-man Kwok, PhD[1], Deborah C. Simmons, PhD[1], Minjung Kim, PhD[1], Leslie E. Simmons, MEd[1], Susan T. Skidmore, PhD[1], Caitlin L. Hernandez, MS[1], and Maureen McSparran Ruby, PhD[3]

Abstract

This exploratory study examined the influences of student, teacher, and setting characteristics on kindergarteners' early reading outcomes and investigated whether those relations were moderated by type of intervention. Participants included 206 kindergarteners identified as at risk for reading difficulties and randomly assigned to one of two supplemental interventions: (a) an experimental explicit, systematic, code-based program or (b) their schools' typical kindergarten reading intervention. Results from separate multilevel structural equation models indicated that among student variables, entry-level alphabet knowledge was positively associated with phonemic and decoding outcomes in both conditions. Entry-level rapid automatized naming also positively influenced decoding outcomes in both conditions. However, its effect on phonemic outcomes was statistically significant only among children in the typical practice comparison condition. Regarding teacher variables, the quality of instruction was associated with significantly higher decoding outcomes in the typical reading intervention condition but had no statistically significant influence on phonemic outcomes in either condition. Among setting variables, instruction in smaller group sizes was associated with better phonemic outcomes in the comparison condition but had no statistically significant influence on outcomes of children in the intervention group. Mode of delivery (i.e., pullout vs. in class) had no statistically significant influence on either outcome variable.

Keywords

early identification, early intervention, early literacy, intervention

Issues surrounding children's early reading acquisition are complex and multidimensional. A converging body of evidence has documented the positive influence of early intervention on early reading outcomes (Cavanaugh, Kim, Wanzek, & Vaughn, 2004; Gersten et al., 2009), but the majority of investigations have focused largely on student characteristics (e.g., Al Otaiba & Fuchs, 2002, 2006; Chard et al., 2008; Nelson, Benner, & Gonzalez, 2003). In this study we (a) expanded the focus to also consider the potential effects of teacher and setting characteristics on kindergarteners' reading achievement and (b) investigated the extent to which type of reading intervention moderated their impact on kindergarten reading outcomes. By expanding the focus to multiple contexts, the goal was to gain insight into how to design more effective interventions and better understand factors associated with early reading growth.

Conceptual Framework for

[1]Texas A&M University, College Station, TX, USA
[2]University of Connecticut, Storrs, CT, USA
[3]Eastern Connecticut State University, Willimantic, CT, USA

Corresponding Author:
Shanna Hagan-Burke, Texas A&M University, 4225 TAMU, College Station, TX 77843, USA.
Email: shaganburke@tamu.edu

Understanding Influences on Early Reading Acquisition

More than a decade ago, Lyon and Moats (1997) encouraged the field to move beyond the important but single-dimensional question of whether an intervention works toward research that examines the contexts that optimize learning to read. Our conceptual framework for examining kindergarten reading outcomes is derived from Mosenthal's (1984) contexts pyramid model of reading. His model encompassed five interrelated contexts along with combinations of variables referred to as meaning sources and meaning processes. Acknowledging the model's complexity, Mosenthal advised against the use of a "fully specified" (p. 203) version and recommended that researchers develop partially specified models to identify the most parsimonious explanations of reading. His summary of partial specification options included five paradigms reflecting different combinations of contextual variables (see Mosenthal, 1984, p. 208). Implicit in this multicontextual model of learning is the belief that student progress or lack thereof may be attributable to multiple factors. In the present study, we focused on three contexts in Mosenthal's model: learner (i.e., students' entry-level language and literacy skills), situation organizer (i.e., teachers and their experience, knowledge, and quality of instruction), and setting (i.e., location and group size).

This heightened interest in the variables and conditions that contribute to kindergarten reading acquisition is timely, especially as the field conceptualizes instructional supports within a multitiered intervention approach. When researchers and practitioners have access to more fine-grained information about which intervention components work for which students under which conditions, they are able to make better decisions about designing, implementing, and adjusting interventions to meet the needs of individual students.

Student Characteristics

When examining early reading outcomes, potentially salient characteristics include entry-level language and literacy knowledge, experience, and demographics. The majority of studies of children at risk for reading problems have investigated whether individual differences among student variables influence reading outcomes. For example, Nelson et al. (2003) conducted a meta-analysis of learner characteristics related to students' response to beginning reading intervention based on an examination of 30 peer-reviewed intervention studies of students at risk for reading disabilities from preschool to third grade. Using z_r effect size estimators (i.e., Fisher z transformed correlations; Hedges & Olkin, 1985) to examine the relative strength of various student variables in predicting reading outcomes, Nelson et al. (2003) found effects for rapid naming (z_r = .51), problem behavior (z_r = .46), phonological awareness (z_r = .42), alphabetic principle (z_r = .35), and memory (z_r = .31). Unlike the academic predictors in Nelson et al.'s findings, problem behavior was inversely associated with reading outcomes. Higher levels of problem behavior were associated with lower reading outcomes. In an experimental study of response to early reading intervention, Al Otaiba and Fuchs (2006) found statistically significant differences between students in kindergarten or first grade who were nonresponsive to generally effective early literacy intervention versus those children who were responsive to intervention on measures of problem behavior (d = –1.20), language development (d = 1.72), receptive vocabulary (d = 1.60), sentence imitation (d = 1.06), word discrimination (d = 0.94), pretreatment letter naming speed (d = 1.57), pretreatment letter sounding speed (d = 1.23), and pretreatment phonemic awareness (d = 0.66). The only nonsignificant difference between nonresponsive and always responsive children in Al Otaiba and Fuchs's (2006) study was on sentence imitation (measure of verbal memory or encoding). Chard et al. (2008) examined the reading development of students receiving multitier early reading supports during kindergarten through third grade. Results showed that students' first grade letter naming (r = .36 to .40, $p < .05$), word identification (r = .54 to .62, $p < .05$), and pseudoword reading (r = .59 to .66, $p < .05$) were strongly related to their oral reading fluency at the end of first, second, and third grade. Finally, a predictive validity study involving more than 900 kindergarten children found that measures of letter names, letter sounds, naming speed, and phonological awareness were reliable predictors of end of first and second grade reading performance (Schatschneider, Fletcher, Francis, Carlson, & Foorman, 2004).

Although student measures varied across studies, prior research suggests considerable commonality among factors that characterize primary grade children who fail to benefit adequately from intervention. In the majority of studies, students who entered with lower entry-level performance (e.g., letter name, letter sound, and phonemic awareness tasks; memory and automatic retrieval difficulties; and classroom behavior) experienced less growth than students with higher entry scores. In the present study, we extended prior early reading intervention research on student characteristics by examining not only factors associated with growth but also how different types of intervention may moderate the impact of entering kindergarten with limited alphabetic, phonemic, and automatized naming proficiency.

Teacher Variables

Teachers' experience, skills, and knowledge can influence student learning outcomes (Goe, 2007; Goe & Stickler, 2008; Greenwald, Hedges, & Laine, 1996; Heck, 2007;

Nougaret, Scruggs, & Mastropieri, 2005). For example, Greenwald et al. (1996) found that teaching ability, years of experience, and teacher education level yielded the three largest effect sizes (expressed as median regression coefficients) among all of the variables in their meta-analysis: .072, .048, and .043, respectively. Recently, Goe (2007) synthesized published studies between 2000 and 2007 that focused on teacher-related variables and their influences on student achievement. Although this synthesis identified a few consistent predictors of student achievement (e.g., teacher experience, level of mathematics knowledge among secondary math teachers), it highlighted many areas with weak or inconsistent findings and concluded that the research on teacher variables that influence student learning outcomes is far from definitive. In the present study, we focused on teachers' phonemic knowledge, instructional quality, and experience teaching kindergarten.

Phonemic knowledge. Investigations of the influence of teachers' literacy knowledge on student achievement have yielded inconsistent and complex patterns of results. Although some studies documented significant linkages between knowledge of reading and student achievement (Foorman & Moats, 2004; McCutchen et al., 2002), others reported mixed associations. For example, Brownell et al. (2009) recently found that although beginning special education teachers had "reasonable" (p. 404) levels of word analysis knowledge, including knowledge of phonological awareness, the relation between teachers' knowledge and their decoding practices during reading instruction was not statistically significant. Similarly, in a study involving 141 teachers (105 kindergarten teachers) who were preparing English language learners to read in Spanish or English, Cirino, Pollard-Durodola, Foorman, Carlson, and Francis (2007) found no significant relation between teachers' domain knowledge (i.e., phonological, orthographic, and morphographic knowledge) and kindergarteners' reading achievement. In contrast, McCutchen et al. (2002) found that increasing kindergarten and first grade teachers' knowledge of English phonology and orthography was positively associated with student achievement. Brady and colleagues (2009) noted that although the majority of professional development studies provide encouraging results with respect to improved teacher knowledge, further research is needed regarding the level of knowledge necessary to affect student achievement.

Quality of instructional practices. Quality of instruction is another teacher variable that may influence early reading achievement. A well-established body of research has identified characteristics of effective teaching, that is, teaching practices that are positively associated with student outcomes (Bohn, Roehrig, & Pressley, 2004; Evertson, Emmer, & Brophy, 1980; Nougaret et al., 2005; Rosenshine, 1986; Sanford & Evertson, 1981; Sindelar, Gartland, & Wilson, 1984). Teaching quality here refers to *how* one teaches rather than *what* it taught (Mosenthal, 1984). Managing instructional time (Bohn et al., 2004; Brophy, 1987; Rowan, Correnti, & Miller, 2002), offering abundant opportunities for students to respond (Brophy, 1982; Grace, 1986; Greenwood, Delquadri, & Hall, 1984; Rieth & Evertson, 1988; Weade & Evertson, 1988), and delivering immediate and specific corrective feedback (Rosenshine & Stevens, 1986) are among the effective teaching practices identified in the research literature.

Kindergarten teaching experience. Another teacher variable sometimes reported to influence student achievement is amount of teaching experience. Rivkin, Hanushek, and Kain (2005) found that years of teaching experience had small but statistically significant effects on student outcomes. In a larger synthesis of teacher-related variables that affect student achievement, Goe (2007) also found that years of teaching experience benefited student outcomes. However, level of experience mattered most during the first 5 years of teaching. Goe noted that after the first 5 years, "there is no evidence that increasing experience contributes additional impact" (p. 18).

For decades, researchers have posited that teacher variables interact with students' response to instruction (Mosenthal, 1983, 1984). In the present study, we were interested in whether teachers' phonemic knowledge, quality of instructional practices, and years of experience influenced student achievement. We were also interested in whether the strength of those influences varied by the type of intervention children received.

Setting Characteristics

Setting variables characterize aspects of the environment where intervention is delivered. Few studies have investigated whether features of the instructional setting moderate early literacy outcomes. Scammacca, Vaughn, Roberts, Wanzek, and Torgesen (2007) synthesized the intervention research targeting struggling readers and identified small-group instruction as a characteristic of effective reading intervention. However, the authors noted that most relevant studies did not directly test for relations between the size of the small instructional groups and student achievement. Foorman and Torgesen (2001) also identified small-group instruction as a critical feature of instruction for children at risk for reading difficulties, explaining that one-on-one or small-group instruction was one of the most practical means of intensifying instructi on for at-risk learners. A recently published practice guide for response to intervention in the primary grades (Gersten et al., 2009) concurred, recommending that children at heightened risk for early reading problems receive intensive, systematic instruction on foundational reading skills in small groups of no more than three to four students.

Although there is broad agreement that small-group instruction is a critical feature of effective reading intervention for at-risk learners, there is little guidance for where supplemental reading instruction should be delivered, that is, whether it is more advantageous to deliver small-group reading instruction in another setting (i.e., pullout model) or whether small-group instruction delivered in the general education classroom is comparable. In intervention models, where both pullout interventions and smaller group sizes are resource intensive, further research is needed to validate the importance of these alterable setting variables.

In summary, although few intervention studies have examined the potential moderating influence of setting variables on kindergarten reading outcomes, initial evidence suggests that setting factors may be important. In this study, we focused on two setting characteristics: (a) the group size in which supplementary reading support was delivered and (b) whether intervention was delivered inside or outside of the general education classroom.

Purpose of the Study

This study extends prior research from an experimental investigation comparing the effects of two supplemental interventions on kindergarten students' reading achievement (Simmons et al., 2011). In the previous efficacy study, 206 students from 57 kindergarten classrooms were determined to be at risk for reading problems and randomly assigned to one of two intervention conditions: an explicit and systematic commercial program or schools' typical intervention practices for kindergarteners at risk of poor reading outcomes.

Both interventions supplemented classroom instruction and were taught 30 minutes per day in small groups for approximately 100 sessions over 21 weeks. At the end of the study, the majority of students in both conditions performed above the 30th percentile on phonemic and reading measures, although the number of responders varied considerably by measure. Children in the more explicit and systematic intervention condition outperformed the school-designed typical intervention practice condition on foundational alphabetic, phonemic, and untimed decoding skills. Substantively important effect sizes favored the more explicit and systematic group on all measures except word identification and passage comprehension.

The present study extends the literature on early reading interventions in two fundamental ways. First, it uses multilevel structural equation analyses to study the influence of variables within three separate contexts (i.e., student, teacher, and setting) on kindergarten children's response to extensive, supplemental beginning reading intervention. Second, it is unique among current studies in its examination of the interaction between context variables and type of intervention (i.e., explicit and systematic code-based instruction or school-designed typical practice intervention) to determine whether intervention moderates the influence of student, teacher, and setting variables.

Building on the results of the previous kindergarten intervention study (Simmons et al., 2011), we addressed the following questions: (a) What are the separate influences of student, teacher, and setting factors on at-risk kindergarteners' reading achievement? and (b) Does type of supplemental reading intervention (i.e., explicit, code-based, or typical school intervention) moderate the strength of association among student, teacher, and setting factors and achievement?

Method

Settings and Participants

The study was part of an experimental efficacy study of supplemental kindergarten interventions conducted in 4 schools in south-central Texas and 8 schools in Connecticut. Of the 12 schools, 11 received Title I funding and served large numbers of children from low-income homes. Percentages of students receiving free and reduced-cost lunch ranged from 69% to 81% in Texas and from 50% to 81% in Connecticut. Enrollments ranged from 278 to 985 students in the participating Texas schools and from 266 to 749 in the Connecticut schools. Kindergarten students in each classroom who were identified as at risk for reading problems were randomly assigned at the classroom level to either the explicit, systematic, code-based condition (ESC; $n = 31$) or the school's typical intervention practices (TIP; $n = 26$).

Teachers

Each school determined whether supplementary reading intervention would be provided by classroom teachers, paraprofessionals, or reading specialists. Interventionists provided information about their current teaching certification. Of the interventionists in the ESC condition, 26 (83.9%) reported that they were fully certified to teach kindergarten, and 21 (80.8%) of the TIP interventionists were fully certified. Among the interventionists, 31 held a bachelor's as their highest earned degree earned, 17 held graduate degrees, and 9 had less than a 4-year degree. Interventionists' years of teaching experience averaged 12.16 in the ESC condition and 14.12 in the TIP condition. To assess equivalence of interventionist demographics between conditions, chi-square analyses were conducted on categorical data, and independent-samples t tests were used for continuous variables. Analyses revealed no statistically significant group differences (i.e., all p values were larger than .05) on the interventionists' gender, total years of teaching experience, years of kindergarten teaching experience, highest degree attained, ethnicity, or primary language.

Table 1. Characteristics of Student Participants by Condition.

	ESC (n = 112)		TIP (n = 94)	
Variable	*n*	%	*n*	%
Age				
M	5.49		5.39	
SD	0.32		0.27	
Gender				
Male	59	52.68	47	50.00
Female	53	47.32	47	50.00
Ethnicity				
Asian	1	0.89	0	0.00
American Indian or Alaska Native	1	0.89	0	0.00
Black or African American	24	21.43	15	15.96
Hispanic or Latino	44	39.29	42	44.68
White	42	37.50	37	39.36
Special education services	15	13.39	9	9.57
Speech and language	14	12.50	8	8.51
Developmental delay	1	0.89	1	1.06
Bilingual or English language learner	24	21.43	29	30.85
Receptive vocabulary knowledge[a]				
M	87.55		88.74	
SD	15.03		15.33	

Note: ESC = explicit, systematic, code-based condition; TIP = typical intervention practice condition.
[a]Vocabulary measures are standard scores from the *Peabody Picture Vocabulary Test–Third Edition* (Dunn & Dunn, 1997) administered at the beginning of the study.

Students

Student participants were identified within the first 6 weeks of kindergarten. To be eligible, a child had to be at least 5 years of age, receiving reading instruction in English and considered in need of supplemental reading support. First, school personnel examined existing screening data and consulted with kindergarten teachers to nominate six to eight kindergarteners per classroom as potential participants. Next, researchers screened nominees with parental consent using the Letter Naming Fluency subtest (LNF) of the *Dynamic Indicators of Basic Early Literacy Skills* (DIBELS; Good & Kaminski, 2002) and the Sound Matching subtest (SM) of the *Comprehensive Test of Phonological Processing* (CTOPP; Wagner, Torgesen, & Rashotte, 1999). Children who scored at or below the 33rd percentile on the LNF measure or at or below the 37th percentile on SM were determined to be at risk for reading problems and were included in the study. (Of the 206 children who completed the study, 136 met both criteria, 64 met the phonemic awareness criterion only, and 6 qualified solely on the LNF measure.) Table 1 summarizes student participants' age, gender, ethnicity, special education status, language status, and entry-level receptive vocabulary.

A total of 232 children began the study. Of those, 206 (89%) participated in both pretest and posttest assessments. There was no statistically significant relation between condition and attrition; 6.93% of TIP students and 13.85% of ESC students did not complete the study.

Outcome Measures of Decoding and Phonemic Skills

Decoding and Reading. We assessed children's end-of-kindergarten decoding outcomes using four subtests from the *Woodcock Reading Mastery Test–Revised–NU* (WRMT-R/NU; Woodcock, 1987/1998) and the DIBELS Nonsense Word Fluency subtest (NWF) (Good & Kaminski, 2002).

Letter name and letter sound knowledge. The WRMT-R/NU Supplementary Letter Checklist for lowercase letters, Form G (Woodcock, 1987/1998) was used to measure letter-name and letter-sound knowledge. To measure letter-name knowledge, the child is asked to identify lowercase letters presented in a randomized format. The measure contains 29 letters, accounting for two variations each of the letters a, g, and q. Letter-sound knowledge was assessed using a similar format (i.e., students are presented with letters in random order and asked to produce their sounds). In addition to the 29 individual letters presented, this measure includes 7 commonly occurring phonemic combinations (e.g., ch or oo) for a total of 36 stimulus items. Both of these alphabet-knowledge measures are criterion based with no standardized scores.

Word attack. The Word Attack subtest of the WRMT-R/NU, Form G (Woodcock, 1987/1998) was used to assess word reading skills. This subtest requires students to read

Table 2. Zero-Order Correlations for All Variables in the Contextual Models.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1. SM1_std	—																		
2. RON1_std	.065	—																	
3. PPVT1_std	.119	.193**	—																
4. LI1_std	.134	.182**	.097	—															
5. LNF1_per	.068	.170*	−.065	.684**	—														
6. SLC2–Name	.048	.195**	.202**	.459**	.336**	—													
7. SLC2–Sound	.059	.271**	.115	.445**	.355**	.832**	—												
8. WA2_std	.034	.283**	.148*	.434**	.269**	.555**	.724**	—											
9. WI_std	.133	.245**	.144*	.563**	.321**	.668**	.741**	.783**	—										
10. NWF2_per	−.001	.353**	.122	.372**	.280**	.587**	.714**	.689**	.647**	—									
11. PSF2_per	.012	.174*	.173*	.218**	.105	.340**	.423**	.452**	.433**	.431**	—								
12. BW2_std	.080	.134	.072	.440**	.254**	.444**	.518**	.586**	.625**	.413**	.405**	—							
13. YearsTK	.047	.018	.160*	−.083	−.097	−.095	−.192**	−.185**	−.150*	−.168*	−.027	−.084	—						
14. Certification	−.068	−.049	−.295**	.059	.071	−.069	−.078	−.028	.017	−.025	−.042	.049	.000	—					
15. PhonKnow	−.136	−.024	−.095	−.062	−.112	−.080	−.087	−.050	−.045	−.002	.006	−.035	.045	.326**	—				
16. Pullout	−.021	−.011	.188**	.027	−.140*	.031	.131	.143*	.156*	.143*	.254**	.085	−.292**	−.552**	.084	—			
17. QualityInstr	−.062	−.009	−.022	.048	.081	.149*	.275**	.271**	.196**	.266**	.211**	.154*	−.163*	.123	−.026	.134	—		
18. GroupSize	.109	.025	.057	.124	−.035	.082	.057	−.028	.017	−.012	.018	−.059	.085	.157*	.098	−.120	−.036	—	
19. ESC	−.004	−.098	−.039	−.048	.035	.067	.152*	.144*	.033	.115	.133	.113	−.116	.065	−.078	−.021	.468**	.076	—

Note: $N = 206$. SM1_std = *Comprehensive Test of Phonological Processing* (CTOPP) Sound Matching standard score at Time 1; RON1_std = CTOPP Rapid Object Naming standard score at Time 1; PPVT1_std = *Peabody Picture Vocabulary Test* standard score at Time 1; LI1_std = *Woodcock Reading Mastery Test* (WRMT) Letter ID standard score at Time 1; LNF1_per = *Dynamic Indicators of Basic Early Literacy Skills* (DIBELS) Letter Naming Fluency percentile score at Time 1; SLC2–Name = WRMT Letter Name Checklist raw score at Time 2; SLC2–Sound = WRMT Letter Sound Checklist raw score at Time 2; WA2_std = WRMT Word Attack standard score at Time 2; WI2_std = WRMT Word Identification standard score at Time 2; NWF2_per = DIBELS Nonsense Word Fluency percentile score at Time 2; PSF2_ = DIBELS Phonemic Segmentation Fluency percentile score at Time 2; BW2_std = CTOPP Blending Words at Time 2; YearsTK = teachers' years of experience of teaching kindergarten; PhonKnow = teachers' phonemic knowledge score; Pullout = dummy variable for pullout group; QualityInstr = teachers' quality of instruction percentage score; GroupSize = number of students in a group; ESC = dummy variable for explicit, systematic, code-based condition group.
*$p < .05$, two-tailed. *$p < .01$, two-tailed.

combinations of letters forming nonwords or low-frequency words in the English language. Reliability coefficients for kindergarten are not reported; however, split-half reliability coefficients for first-, third-, and fifth-grade students ranged from .91 to .98, with the coefficient decreasing as grade level increases. Age-based standard scores were used in analyses.

Nonsense word fluency. The DIBELS NWF subtest (Good & Kaminski, 2002) measures phonological recoding. Students are presented with a list of vowel-consonant and consonant-vowel-consonant nonwords (e.g., ig, tav) and asked to read each entire word or to verbally produce each letter sound. The final score is the total number of correct sounds produced in 1 minute. The alternate-form reliability for this subtest for the normative kindergarten sample is .88.

Word identification. The Word Identification subtest of the WRMT-R/NU, Form G (Woodcock, 1987/1998) requires a child to read whole words of increasing difficulty. Reliability coefficients are not detailed for kindergarten. First-, third-, and fifth-grade students' scores range in split-half reliability coefficients from .89 to .94, with the coefficients decreasing as grade level increases. Age-based standard scores were used in analyses.

Phonemic Awareness. Two measures were administered at posttest to assess children's phonemic awareness (i.e., blending and segmenting) at the end of kindergarten.

Phonemic blending. The Blending Words subtest (BW) of the CTOPP battery (Wagner et al., 1999) requires students to verbally blend individual sounds presented via audiotape. Items increase in difficulty and length as the test progresses. Internal reliability with alpha coefficients ranges from .86 to .89 for children ages 5 through 7 in the normative sample. Age-based standard scores were used in analyses.

Phonemic segmentation fluency. The DIBELS Phonemic Segmentation Fluency subtest (PSF; Good & Kaminski, 2002) measures a student's ability to fluently segment three- and four-phoneme words. Scores indicate the number of sound segments correctly identified in 1 minute. Alternate-form reliability for the normative kindergarten sample is .88.

Contextual Predictor Variables

Student Characteristics. Prior to intervention, we assessed students' entry-level language and reading-related skills using measures of alphabet knowledge, phonemic awareness, receptive vocabulary, and rapid automatized naming.

Alphabet knowledge. Entry-level alphabet knowledge was assessed using a 1-minute measure of letter naming fluency and an untimed measure of letter naming ability. The LNF subtest of DIBELS (Good & Kaminski, 2002) measures the ability to rapidly name upper- and lowercase letters presented in a random sequence for 1 minute. The alternate-form reliability for this subtest for the kindergarten normative sample is .89. The mean percentile score for LNF at pretest was 28.83 (*SD* = 19.57) in the ESC condition and 27.35 (*SD* = 22.48) in the TIP condition.

The Letter Identification subtest (LI) of the WRMT-R/NU (Woodcock, 1987/1998) is a standardized, untimed test that assesses the ability to name upper- and lowercase letters in various fonts. The split-half reliability coefficient for this subtest is .94 for the first grade sample (coefficient for kindergarten sample not reported). The mean standard score for the LI subtest at pretest was 87.04 (*SD* = 10.21) in the ESC condition and 88.09 (*SD* = 11.52) in TIP.

Phonemic awareness. The SM subtest of the CTOPP battery (Wagner et al., 1999) was used to measure entry-level phonemic awareness. In this subtest, items contain a stimulus picture and three additional pictures. Children are asked to select the picture that begins (or ends, depending on skill level) with the same sound as the stimulus picture. Sound matching consists of 20 identification tasks (10 first-sound followed by 10 last-sound items). Alpha coefficients of reliability for children ages 5, 6, and 7 range from .92 to .93. Pretest standard scores on the SM were 7.68 (*SD* = 1.10) in ESC and 7.69 (*SD* = 1.15) in TIP. For children ages 5.0 to 5.5, a standard score of 7 corresponds with the 16th percentile and a standard score of 8 corresponds with the 25th percentile.

Receptive vocabulary. The *Peabody Picture Vocabulary Test–Third Edition* (PPVT-III; Dunn & Dunn, 1997) was used to determine entry-level receptive vocabulary knowledge. For each item, a child is shown a card with four pictures and asked to point to the picture depicting the word an examiner provides. Alpha reliability coefficients reported in the PPVT-III manual for students in kindergarten range from .94 to .95 for Form A. The mean pretest standard scores for PPVT-III were 87.55 (*SD* = 15.03) and 88.74 (*SD* = 15.33) for the ESC and TIP conditions, respectively.

Rapid automatized naming. The Rapid Objects Naming subtest of the CTOPP battery (Wagner et al., 1999) was used to measure entry-level rapid automatized naming (RAN) ability. Prior to testing, the examiner shows the child pictures of six objects and ensures that the child can correctly identify each object. During the timed administration, the child is presented with a card containing the six preidentified objects printed multiple times in random order. The task is to orally identify the items as quickly as possible. The task is given twice, and a child's score reflects the total amount of time required to complete both administrations. The CTOPP manual lists alternate-form reliability coefficients of .79 to .82 for the 5-, 6-, and 7-year-olds. Children in the ESC condition averaged a standard score of 7.65 (*SD* = 3.16), and TIP children averaged a score of 8.26 (*SD* = 2.98). For children ages 5.0 through 5.5, standard scores of 7 and 8 correspond with the 16th and 25th percentiles, respectively.

Teacher Variables. To examine the potential influence of teacher variables on kindergarteners' response to supplemental reading intervention, we considered (a) interventionists' years of experience teaching kindergarten, (b) whether they were certified teachers, (c) level of phonemic knowledge, and (d) quality of generic instructional practices.

Years of kindergarten teaching experience. Prior to the study, interventionists (including paraprofessionals) self-reported demographic information that included years of kindergarten teaching experience. Paraprofessionals reported the number of years they had worked with kindergarten children in school settings. Years prior to the current school year were counted. For interventionists who were beginning their first year of teaching kindergarten, a zero was coded for this variable. Teachers in the ESC had an average of 6.08 years of teaching experience (SD = 6.92); teachers in the TIP condition averaged 7.92 (SD = 8.89) years of experience.

Teachers' phonemic awareness knowledge. Prior to the start of the study, interventionists in both conditions completed a questionnaire designed to assess their knowledge of phonemic awareness. The brief questionnaire assessed interventionists' understanding of phonemic awareness (three items) and knowledge of phonemic awareness instruction (three items). An example item designed to assess interventionists' understanding of phonemic awareness was,

> Phonemic awareness is: (a) the same thing as phonics, (b) understanding the relationships between letters and the sounds they represent, (c) understanding that text can be pronounced orally, (d) ability to identify and work with the individual sounds in spoken words, or (e) I'm not sure.

An item that assessed interventionists' knowledge of phonemic awareness instruction was

> An example of explicit phonemic awareness instruction is: (a) teaching common letter-sound correspondences of the 26 letters of the alphabet to mastery, (b) identifying the initial sound in a spoken word, (c) practicing kindergarten curriculum sight words, to a high level of fluency, in whole group and small group formats, (d) air writing the individual letters of the alphabet while singing the alphabet song to reinforce orthography, (e) all of the above, or (f) I'm not sure.

The questionnaire's items were drawn from a nine-item measure of teachers' knowledge about phonemic awareness instruction (Cheesman, McGuire, Shankweiler, & Coyne, 2009). Items that were relevant to kindergarten reading instruction and aligned with the focus of the study's intervention were selected.

Teachers in the ESC condition completed the questionnaire on the day they attended professional development. Those in the TIP group were given the assessment at their schools on the same day that research staff administered pretest measures to student participants. The average raw scores on the phonemic knowledge measure were 3.25 (SD = 1.76) and 3.52 (SD = 1.60) for the ESC and TIP groups, respectively.

Quality of teachers' instructional practices. Researchers observed all 57 intervention groups to evaluate the quality of teachers' use of three generic instructional practices identified in the effective teaching literature: (a) managing instructional time, (b) maximizing opportunities to respond, and (c) providing corrective feedback. Although the ESC curriculum prompted teachers to solicit opportunities to respond and provide corrective feedback, these generic instructional behaviors were relevant across both interventions conditions.

Teachers in the TIP condition were observed twice (late fall and early spring), and ESC teachers were observed three times (fall, winter, spring). During each observation, researchers used a 4-point Likert scale (1 = *poor*, 2 = *fair*, 3 = *good*, 4 = *excellent*) to rate the extent to which teachers engaged in these instructional behaviors. Each of these instructional practices was rated during each lesson activity and converted to a percentage. For example, if a lesson included seven activities, there were three instructional practice ratings per activity. The rating values were summed and divided by 21 (the total number of ratings) to generate the percentage of points possible for an overall score. The range of points possible for a given activity was from 3 (i.e., observers rated all three instructional practice items as 1) to 12 (i.e., observers rated all three instructional practice items as 4).

Within the ESC condition, the quality of teachers' instructional practices scores ranged from 55.56% to 95.11%, with an average of 75.47% (SD = 8.45). In TIP, teachers' quality scores ranged from 43.75% to 65.50%, with an average score of 65.50% (SD = 10.47). Interrater reliability was established using a second independent observer for 25% of the direct observations. Percentage of agreement was calculated as the number of agreements divided by agreements plus disagreements for each component variable of the teacher quality composite score. Average agreement between each pair of raters was 89.25% for managed instructional time, 88.19% for maximized opportunities to respond, and 88.21% for provided corrective feedback.

Setting Variables. To assess the potential influence of instructional setting variables on reading outcomes, we examined the location of supplemental intervention (i.e., pullout vs. in class) and group size.

Pullout versus in-class intervention. Each school determined whether interventions would be delivered within children's general kindergarten classrooms or as a pullout intervention. For schools using a pullout model, children were taught in an alternative small-group setting by another teacher, reading specialist, or paraprofessional. In schools that provided intervention in the kindergarten classroom, the kindergarten teacher provided small-group instruction while the rest of the class typically worked independently at centers. In each participating school, both intervention conditions were delivered using the same model (i.e., both ESC and TIP were delivered in class, or both were delivered via pullout). Of the children in the ESC condition, 38 (40.4%) received intervention via a pullout model, compared to 43 (38.4%) in the TIP condition.

Group size. At the beginning of the study, intervention groups for both conditions included three to five students. As the study progressed, some group sizes decreased because of attrition. For our analyses, group size was calculated by averaging the number of children in each intervention group at three time points distributed across the intervention period. For example, if a group had five students during October, four during January, and three during April, the group size used in analyses was four. The average instructional group size was 3.87 (SD = 0.92) in ESC and 3.74 (SD = 0.62) in TIP.

Interventions

Three components were standard across the two intervention conditions. First, reading intervention was a supplement to general reading instruction and was provided in small groups of three to five students and delivered by school-designated interventionists. Second, intervention was scheduled for 30 minutes every day over the course of 21 weeks. Finally, the instructional content in both conditions focused on early literacy skills.

Explicit, systematic code intervention. In the ESC condition, interventionists used the Early Reading Intervention, a commercial program that provides intensive instruction on key phonemic and alphabetic skills (Pearson/Scott Foresman, 2004). The program consists of 126 half-hour lessons composed of seven activities designed to last 3 to 5 minutes each. The first half of each lesson focuses on phonological awareness and alphabetic understanding; the second half integrates writing and spelling with previously taught phonemic and alphabetic skills. For a more complete description of the Early Reading Intervention program, see Simmons et al. (2011). Teachers in the ESC condition received 2 days of professional development to learn to use the curriculum. On average, students in the ESC condition received a total of 102 lessons (SD = 10.10).

Typical intervention practices. Interventionists in the TIP condition were asked to provide supplementary reading instruction for 30 minutes daily using their customary materials and procedures. TIP interventionists did not receive formal professional development as part of the study; however, schools were not prohibited from providing professional development. In this condition, content and instructional approaches were allowed to vary naturally. Some schools had kindergarten intervention options already in place; others used participation in this research study as an opportunity to develop and implement Tier 2 interventions.

Although some schools coordinated intervention at a school level, most allowed interventionists to design and deliver their own selection of early reading intervention. Teachers used a range of materials, with 43% relying on commercial materials exclusively, 54% using self-developed lessons and materials, and 3% using a combination of commercial and teacher-developed materials. On average, students in the typical intervention condition received a total of 106 lessons (SD = 14.87).

Each TIP intervention group was observed twice (fall and spring), and observers documented the types of instructional content addressed during small-group intervention. Across the two observations, TIP teachers focused on a range of beginning reading and literacy skills. During fall observations, alphabetic and decoding skills were a predominant focus of TIP instruction, with 80% of observed activities incorporating instruction on letter names and 73% on letter sounds. The second most prominent focus during fall observations was phonological awareness, with 50% of activities incorporating tasks related to phonological processing. The least observed types of instruction during fall observations were vocabulary (3%) and listening comprehension (7%). During spring observations there were some shifts in emphasis. There was less emphasis on letter names and sounds (48% each) and a larger percentage of activities incorporating vocabulary (29%) and listening comprehension (24%). Relative to fall observations, there were also fewer activities focused on phonemic awareness (29%).

Data Analyses

Data were first checked for normality and potential outliers. Except for letter-name knowledge, the skew and kurtosis of all other variables were within the recommended cutoff values (i.e., skew < 2.0 and kurtosis < 7.0 may be viewed as normally distributed; West, Finch, & Curran, 1995). We adopted the MLR estimation method in Mplus (V5.21; Muthén & Muthén, 1998–2007) for all analyses. MLR produces the maximum likelihood parameter estimates with standard errors and a chi-square test statistic that are robust to nonnormality and nonindependency of observations.

We reduced the number of reading outcome variables by using exploratory factor analysis (EFA) to examine the number of underlying factors and corresponding factor

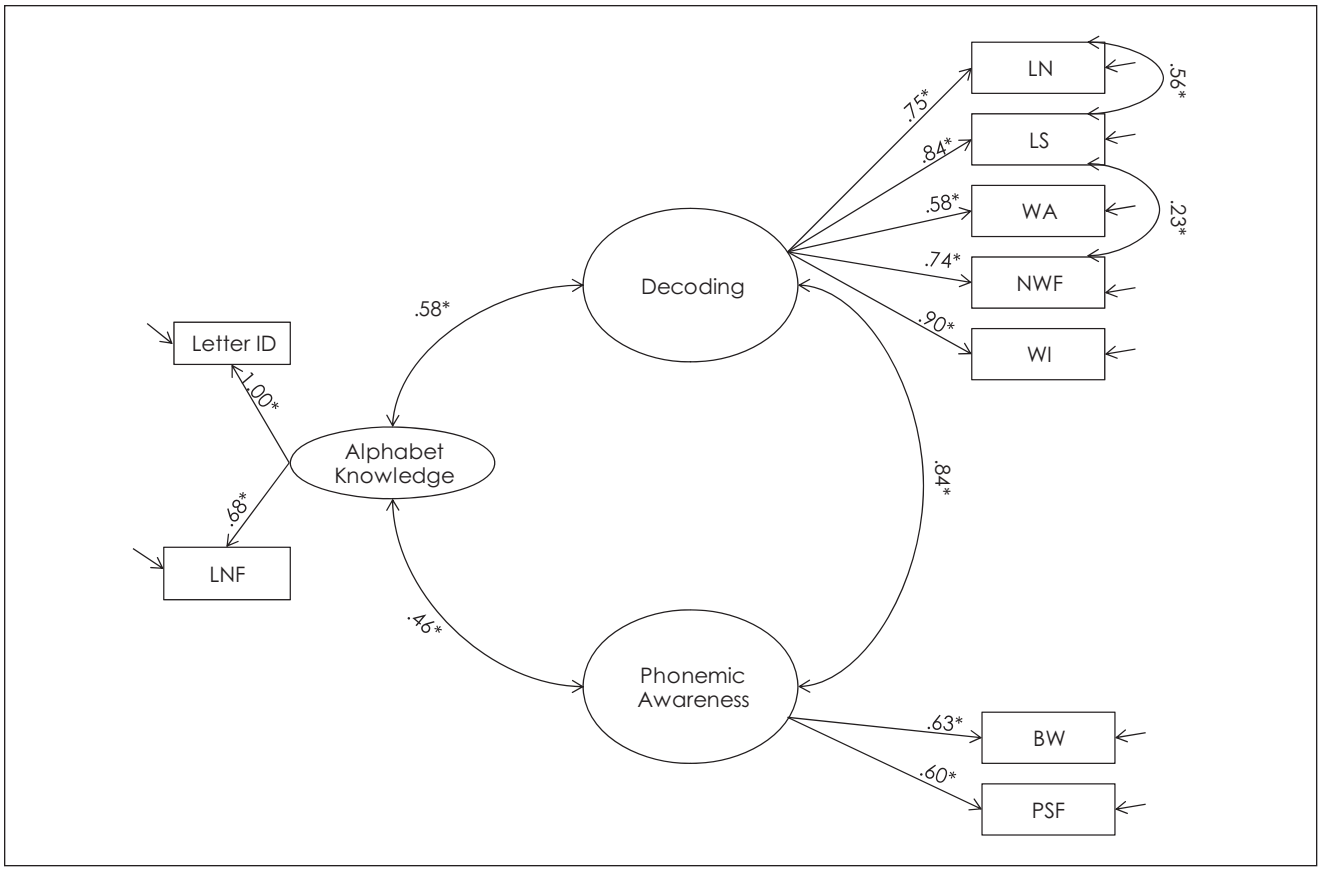

Figure 1. Measurement model.
Note: All coefficients are standardized. Letter ID = *Woodcock Reading Mastery Test–Revised–NU* (WRMT-R/NU) Letter ID standard score on pretest; LNF = *Dynamic Indicators of Basic Early Literacy Skills* (DIBELS) Letter Naming Fluency percentile score on pretest; LN = WRMT-R/NU Supplementary Letter Checklist–Name raw score on posttest; LS = WRMT-R/NU Supplementary Letter Checklist–Sound raw score on posttest; WA = WRMT-R/NU Word Attack standard score on posttest; NWF = DIBELS Nonsense Word Fluency percentile score on posttest; WI = WRMT-R/NU Word Identification standard score on posttest; BW = *Comprehensive Test of Phonological Processing* Blending Words standard score on posttest; PSF = DIBELS Phonemic Segmentation Fluency percentile score on posttest.

structure. We then validated the factor solution through a confirmatory factor analysis (CFA). After confirming the measurement model, we examined the impact of the student, teacher, and setting variables on end-of-kindergarten reading outcomes with three separate confirmatory factor analyses. To account for the multilevel data structure and nonindependent observations in our data, we adopted the "Type = Complex" routine in Mplus (V5.21; Muthén & Muthén, 1998–2007), which adjusts the standard errors of the parameter estimates with the Huber–White correction.

Results

The EFA results showed that a two-factor solution produced a reasonable factor structure in which all decoding-related reading outcome measures (i.e., letter-name knowledge, letter-sound knowledge, word attack, nonsense word fluency, and word identification) clustered together, whereas the two phonemic-related outcomes (i.e., blending words, phonemic segmentation fluency) loaded on a separate factor.

We further examined the fit of this two-factor solution with a hypothesized pretest factor (alphabet knowledge, loaded on by pretest measures of letter name fluency and letter identification). The correlations among all variables, along with the mean and standard deviations for each variable, are presented in Table 2. The hypothesized measurement model is shown in Figure 1, in which all the decoding related outcome variables (i.e., letter-name knowledge, letter-sound knowledge, word attack, nonsense word fluency, and word identification) are loaded on the decoding latent factor, whereas the phonemic-awareness-related outcome variables (i.e., blending words and phonemic segmentation fluency) are loaded on the corresponding latent factor. The standardized factor loadings (i.e., the directional arrows from the latent factors to the observed variables) can be viewed as the strength of the relation between the latent factors and the observed variables.

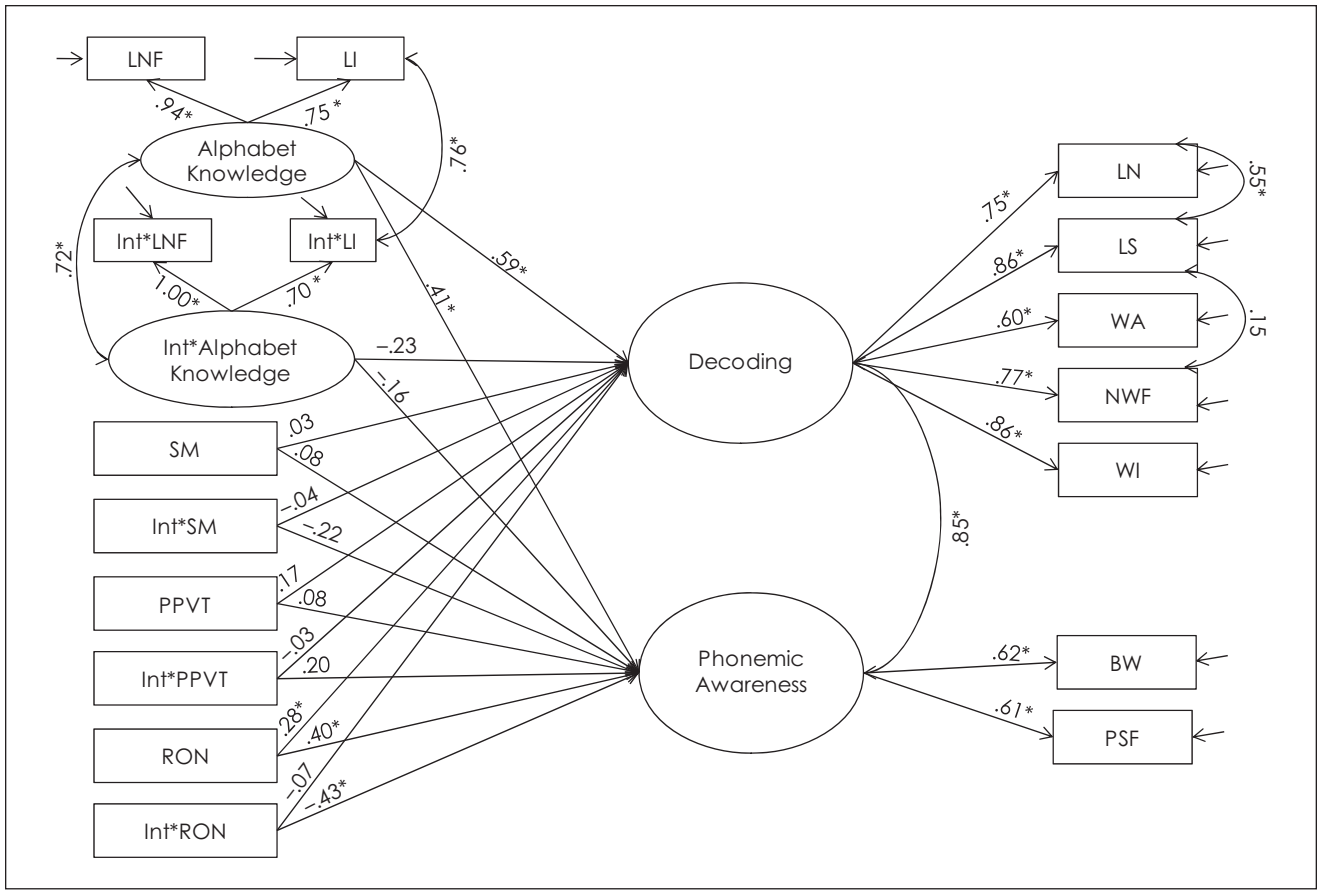

Figure 2. Standardized path coefficients for student characteristic model with intervention interactions

Note: All coefficients are standardized. Intervention condition is not included to reduce the complexity of the figure. LNF = *Dynamic Indicators of Basic Early Literacy Skills* (DIBELS) Letter Naming Fluency percentile score on pretest; LI = *Woodcock Reading Mastery Test–Revised–NU* (WRMT-R/NU) Letter ID standard score on pretest; SM = *Comprehensive Test of Phonological Processing* (CTOPP) Sound Matching standard score on pretest; Int*SM = Type of Intervention by CTOPP Sound Matching interaction effect; PPVT = *Peabody Picture Vocabulary Test* standard score on pretest; RON = CTOPP Rapid Object Naming standard score on pretest; INT = Type of Intervention (TIP/ESC); LN = WRMT-R/NU Supplementary Letter Checklist–Name raw score on posttest; LS = WRMT-R/NU Supplementary Letter Checklist–Sound raw score on posttest; WA = WRMT-R/NU Word Attack standard score on posttest; NWF = DIBELS Nonsense Word Fluency percentile score on posttest; WI = WRMT-R/NU Word Identification standard score on posttest; BW = CTOPP Blending Words standard score on posttest; PSF = DIBELS Phonemic Segmentation Fluency percentile score on posttest.

Although the overall model chi-square value was significant, $\chi^2(23) = 43.15$, $p = .007$, the other fit indices (i.e., root mean square error of approximation [RMSEA] = .07, standardized root mean square residual [SRMR] = .03, and comparative fit index [CFI] = .97) indicated that the hypothesized model fit the data adequately. All factor loadings were significant (at $p < .05$), and each observed reading outcome variable was positively related to its corresponding latent factor. The three latent factors also positively correlated with each other. The explained variances of the observed reading outcome variables ranged from .34 to .99.

Student Characteristics Model: Influences of Entry-Level Language and Literacy Skills

We investigated the influence of entry-level alphabet knowledge (i.e., a latent construct containing both letter name fluency and letter identification), phonemic sound matching, vocabulary (PPVT-III), and rapid object naming (RON) on two outcome factors (i.e., decoding and phonemic awareness). We also tested for interaction effects for each student variable by intervention condition (i.e., ESC or TIP).

The hypothesized model with students' entry-level language and literacy variables is shown in Figure 2, along with the interaction effects between intervention condition and (a) the latent pretest construct (i.e., Int*Alphabet Knowledge) and (b) observed pretest measures (i.e., Int*SM, Int*PPVT, and Int*RON). The model had acceptable fit based on the model indices, although the overall

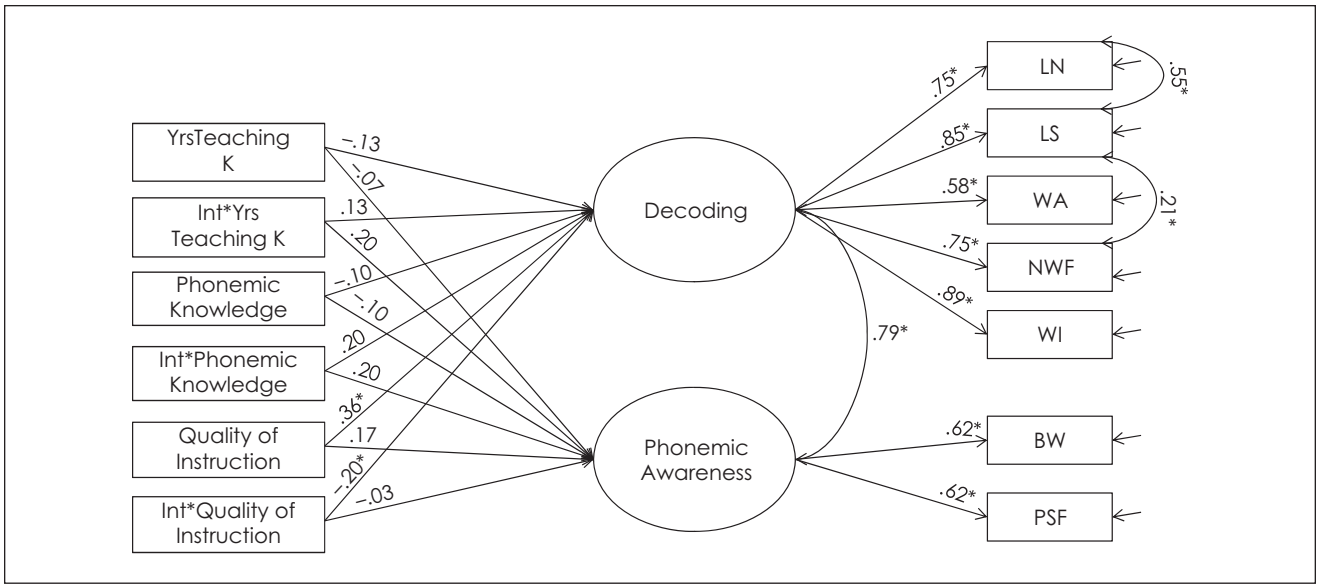

Figure 3. Standardized path coefficients for teacher model with intervention interactions

Note: All coefficients are standardized. Intervention condition, sound matching, and alphabet knowledge are not included to reduce the complexity of the figure. Yrs Teaching K = teachers' years of experience teaching kindergarten; Phonemic Knowledge = teachers' phonemic knowledge; Quality of Instruction = quality of teachers' instructional practices; Int = type of intervention; LN = *Woodcock Reading Mastery Test–Revised–NU* (WRMT-R/NU) Supplementary Letter Checklist–Name raw score on posttest; LS = WRMT-R/NU Supplementary Letter Checklist–Sound raw score on posttest; WA = WRMT-R/NU Word Attack standard score on posttest; NWF = *Dynamic Indicators of Basic Early Literacy Skills* (DIBELS) Nonsense Word Fluency percentile score on posttest; WI = WRMT-R/NU Word Identification standard score on posttest; BW = *Comprehensive Test of Phonological Processing* Blending Words standard score on posttest; PSF = DIBELS Phonemic Segmentation Fluency percentile score on posttest.

model chi-square value was significant, $\chi^2(85) = 156.738$, $p < .0001$; RMSEA = .06, SRMR = .05, CFI = .94. The predictors in this model accounted for 34% of the variance in decoding and 33% of the variance in phonemic awareness. All path coefficients presented below and in Figure 2 are standardized coefficients. The test of significance and the magnitude of the standardized coefficient can be viewed as the predictive power of a particular pretest measure and the corresponding intervention condition by pretest measure interaction effect on the outcome variables. Following is a summary of the results for the student characteristics model.

Two of the four student characteristic variables significantly influenced kindergarten reading outcomes. First, entry-level alphabet knowledge had a statistically significant positive effect on decoding ($\gamma = .59$, $p < .05$) and phonemic awareness ($\gamma = .41$, $p < .05$) outcomes. Regardless of whether students received ESC or TIP, those who performed higher on alphabet-knowledge measures at the beginning of intervention tended to score higher on both decoding and phonemic awareness outcome measures.

RON also had a statistically significant influence on decoding outcomes ($\gamma = .28$, $p < .05$). Students with higher entry-level RON performance tended to score higher on the end-of-year decoding measures, regardless of intervention condition. For phonemic outcomes, however, there was a statistically significant interaction between type of intervention and the influence of entry-level RON performance ($\gamma = –.43$, $p < .05$). Entry-level RON performance was a substantially stronger predictor of phonemic awareness outcomes among children in the TIP condition ($\gamma = .40$, $p < .05$) than those in ESC ($\gamma = –.03$, *ns*).

The remaining two student variables were unrelated to end-of-year reading performance. That is, entry-level receptive vocabulary (as measured by PPVT-III) had no statistically significant influence on decoding or phonemic awareness outcomes, and there were no statistically significant interaction effects between type of intervention and PPVT-III scores. The same was true of entry-level performance on the sound-matching measure. Regardless of condition, neither decoding nor phonemic outcomes were influenced by children's phonemic awareness prior to kindergarten intervention.

Teacher Model: Influences of Experience and Knowledge

We examined the influences of teacher characteristics on student decoding and phonemic awareness outcomes using the following variables: years of kindergarten teaching experience, teacher certification status, phonemic awareness knowledge, and quality of instruction. We also tested

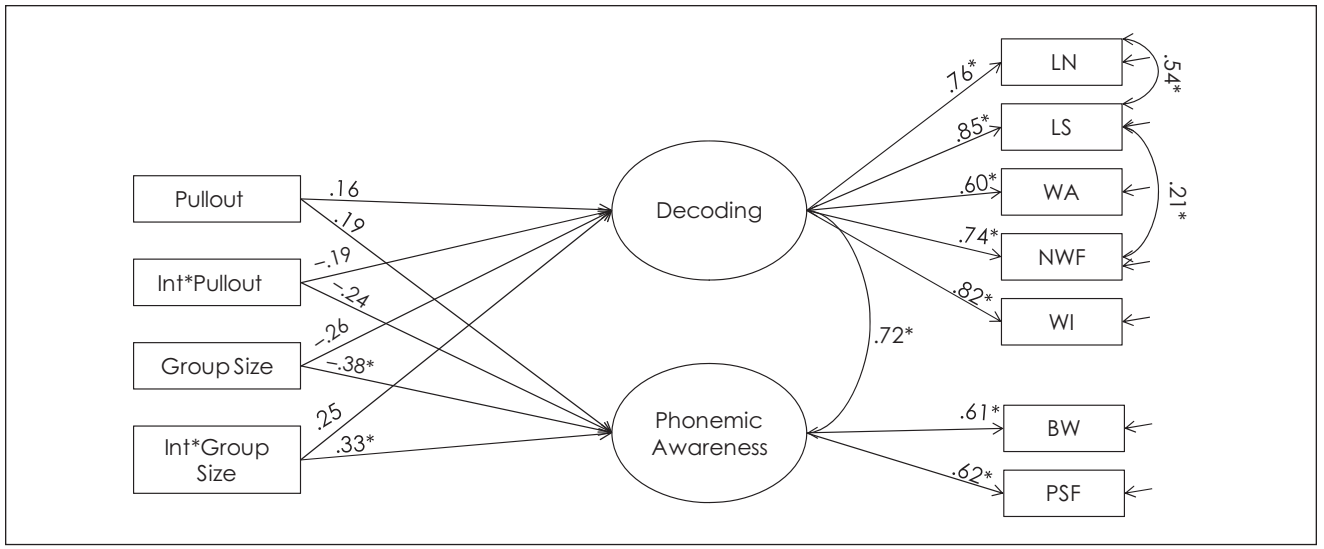

Figure 4. Standardized path coefficients of setting model with intervention interactions

Note: All coefficients are standardized. Intervention condition, sound matching, and alphabet knowledge are not included to reduce the complexity of the figure. Pullout = pullout group identification; Group size = number of students in an intervention group; LN = *Woodcock Reading Mastery Test–Revised–NU* (WRMT-R/NU) Supplementary Letter Checklist–Name raw score on posttest; LS = WRMT-R/NU Supplementary Letter Checklist–Sound raw score on posttest; WA = WRMT-R/NU Word Attack standard score on posttest; NWF = *Dynamic Indicators of Basic Early Literacy Skills* (DIBELS) Nonsense Word Fluency percentile score on posttest; WI = WRMT-R/NU Word Identification standard score on posttest; BW = *Comprehensive Test of Phonological Processing* Blending Words standard score on posttest; PSF = DIBELS Phonemic Segmentation Fluency percentile score on posttest.

the extent to which type of intervention (i.e., ESC vs. TIP) moderated those influences (i.e., Int*Yrs Teaching K, Int*Phonemic Knowledge, and Int*Quality of Instruction in Figure 3) while controlling for students' entry-level alphabet knowledge and sound-matching performance. The hypothesized model illustrated in Figure 3 showed an acceptable fit with the data, $\chi^2(83) = 95.10$, $p = .17$; RMSEA = .03, SRMR = .03, CFI = .99. In all, 45% of the variance in the latent decoding variable and 32% of the variance in the latent phonemic awareness variable were explained by the predictors in this model.

Among the three teacher context variables, only quality of instruction had a statistically significant effect on decoding ($\gamma = .36$, $p < .05$). In addition, there was a statistically significant interaction between type of intervention and quality of instruction ($\gamma = –.20$, $p < .05$). The quality of teachers' instruction was a substantially stronger predictor of decoding outcomes among children in the TIP condition ($\gamma = .36$) than those in the ESC ($\gamma = .16$). The other teacher context variables (i.e., years of experience teaching kindergarten and teacher's phonemic knowledge) had no statistically significant influence on decoding or phonemic awareness outcomes, and there were no statistically significant interaction effects between type of intervention and these any of these teacher context variables. That is, across both ESC and TIP conditions, children tended to score the same on year-end decoding and phonemic measures regardless of their teachers' years of experience and level of phonemic knowledge.

Setting Model: Influences of Location and Group Size

The final model controlled for school effects along with the effects of entry-level alphabet knowledge and sound matching, while investigating the influence of instructional setting features (i.e., location and group size) on reading outcomes. The model also tested interaction effects between these setting variables and type of intervention (i.e., Int*Pullout and Int*Group Size as presented in Figure 4). Although the chi-square value was significant, $\chi^2(123) = 255.349$, $p < .0001$, the other model fit indices showed an acceptable fit to the data (RMSEA = .07, SRMR = .04, CFI = .90). In all, 54% of the variance in decoding outcomes and 60% of the variance in phonemic awareness outcomes were accounted for by the predictors in this model.

After controlling for school effects, intervention delivered via pullout had no influence on decoding and phonemic awareness outcomes, whereas group size had a statistically significant influence on phonemic awareness ($\gamma = –.38$, $p < .05$; $g = .46$). Moreover, the interaction effect between group size and the type of intervention was statistically significant ($\gamma = .33$, $p = .050$; $g = .47$), indicating that group size negatively influenced phonemic outcomes for students in the TIP condition. In other words, students receiving TIP in larger groups tended to score lower on end-of-kindergarten phonemic awareness measures than those taught in smaller TIP groups. Conversely, instructional group size did not influence end-of-kindergarten reading outcomes among students in the ESC condition.

Discussion

The purpose of this study was to extend the research on early reading intervention by examining the influence of three types of contextual variables on at-risk kindergarteners' end-of-year outcomes. In addition, we investigated whether the influence of contextual variables differed by type of supplemental reading intervention. We applied Mosenthal's (1984) contexts pyramid model of reading to construct a partially specified model focused on student, teacher, and setting variables. Specifically, we used multilevel structural equation modeling to (a) investigate the influences of children's entry-level language and literacy skills, teacher knowledge and skills, and setting where supplemental reading intervention took place and (b) examine their impact on the reading performance of children who received either an experimental beginning reading intervention or schools' typical intervention practices for at-risk kindergarteners. According to our analyses, variables within each of the student, teacher, and setting contexts had significant effects on kindergarten children's response to intervention.

Influences of Student Entry-Level Language and Literacy Skills

The student model's predictors accounted for 34% of the variance in the latent decoding variable and 33% in the latent phonemic variable; two of the model's four variables significantly influenced end-of-kindergarten outcomes. Higher entry levels of alphabet knowledge were positively related to decoding and phonemic outcomes regardless of intervention condition. RAN (measured with the CTOPP's RON subtest) was also positively associated with decoding and phonemic measures. However, the intervention condition moderated RAN's influence on phonemic outcomes. Its influence was statistically significant only for children in the TIP condition ($\gamma = .40$, $p < .05$), where children with lower preintervention RAN performance tended to score lower on the composite phonemic measure.

These findings align with prior research supporting the influence of alphabetic knowledge and RAN on kindergarten reading outcomes. For example, in Nelson et al.'s (2003) meta-analysis of student characteristics associated with nonresponse, alphabet knowledge and RON were among the largest predictors of poor outcomes ($z_r = .51$ and $z_r = .42$, respectively). Others have also found alphabet knowledge (Chard et al., 2008; Schatschneider et al., 2004) and rapid naming speed (Al Otaiba & Fuchs, 2006; Schatschneider et al., 2004) to be associated with response to early literacy intervention. Our finding that RAN was predictive of phonemic outcomes only in the TIP condition may be because of the explicit and systematic instruction in phonemic awareness built into the ESC condition. Because of this instructional design feature, it is possible that ESC was sufficient to moderate entry-level RAN's influence on phonemic outcomes. However, for the more complex skills of decoding, RAN continued to influence outcomes irrespective of condition.

The remaining two variables in the student characteristics model did not predict end-of-kindergarten outcomes. Our finding that entry-level vocabulary knowledge (as measured by PPVT-III) had no statistically significant influence on phonemic and decoding outcomes differs from the findings of Al Otaiba and Fuchs (2006), who found that kindergarten PPVT-III performance predicted nonresponse to early reading intervention at the end of first grade. Vocabulary knowledge was not a direct focus of the ESC or TIP conditions (see Authors), and none of the outcome measures assessed vocabulary-related skills. Preintervention PPVT-III performance in the early grades may be a better predictor of outcomes more closely related to vocabulary knowledge and performance during later grades (Storch & Whitehurst, 2002).

Phonemic awareness (as measured by SM subtest of CTOPP) was the other student characteristic in our study that had no statistically significant association with kindergarten reading outcomes, including the phonemic outcome. Many prior studies identified phonemic awareness as a characteristic of children who fail to respond to early reading intervention (Al Otaiba & Fuchs, 2002, 2006; Nelson et al., 2003; Schatschneider et al., 2004). It is possible that this finding is related to our use of a single measure to assess entry-level phonemic awareness.

Influence of Teacher Experience and Knowledge

The predictors in our teacher model explained 45% of the variance in decoding outcomes and 32% of the variance in phonemic awareness. However, only one of the four teacher variables had a statistically significant influence on kindergarteners' end-of-year reading outcomes. End-of-kindergarten decoding outcomes were positively associated with the quality of teachers' instructional practices, which was a composite of managing instructional time, maximizing opportunities to respond, and providing corrective feedback. Moreover, interaction tests indicated that the quality of teachers' instructional practices during intervention had a stronger influence on decoding outcomes in the TIP condition relative to the ESC condition. In general, every *SD* unit increase in a TIP teacher's instructional quality score (i.e., 10.47 percentage points) was associated with a 0.36 *SD* unit gain on latent decoding scores. For ESC teachers, an *SD* unit increase in instructional quality score (i.e., 8.45 percentage points) produced a 0.16 *SD* unit gain on the latent decoding scores.

The finding that instructional quality had greater impact in typical instruction than in ESC may be in part attributable

to the architecture of the program. That is, the intervention program used in the ESC condition was highly structured, with explicit guidance for when to administer group and individual opportunities to respond, offer corrective instructional feedback, and allocate time to specific activities. Such guidance likely increased quality ratings and reduced the variability of these teaching behaviors among ESC interventionists (ESC's mean instructional quality score was 75.47% and *SD* = 8.45; in TIP, the mean was 65.50% and *SD* = 10.47). Average quality rating scores differed by approximately 10 percentage points, favoring the ESC over the TIP condition. This explanation is consistent with Foorman, Francis, Fletcher, Schatschneider and Mehta's (1998) observation that instructional approaches that include explicit and direct instruction that is carefully specified can support teachers' ability to implement instruction with high levels of quality.

Conversely, teachers' phonemic knowledge was unrelated to kindergarten reading outcomes in this study. Prior investigations of teachers' domain knowledge and its influence on early reading outcomes are also inconclusive (Brownell et al., 2009; Cirino et al., 2007; McCutchen et al., 2002). As Brady et al. (2009) surmised, although the evidence to date is promising, more research is necessary to determine the nature and extent of domain knowledge necessary to affect student achievement. Years of kindergarten teaching experience was also unrelated to kindergarteners' response to early reading intervention. Although some prior studies reported small but statistically significant relations between teacher experience and student outcomes, the benefit of experience may level off after the first 5 years (Goe, 2007; Rice, 2003; Rockoff, 2004). Our analyses treated years of experience as a continuous variable. It is possible that categories of experience on a 6-point scale ranging from 0 to 5 or more years may be a more effective way to measure teacher experience.

Setting Influences: Location of Intervention and Group Size

The setting context model examined the influences of location of intervention (i.e., pullout vs. in class) and group size on kindergarteners' response to supplementary reading intervention. The model's predictor variables accounted for 54% of the variance in decoding outcomes and 60% of the variance in phonemic outcomes. Neither of the model's variables had a statistically significant influence on decoding outcomes. However, the size of intervention groups had a statistically significant influence on phonemic outcomes, and that relation was moderated by type of intervention. More specifically, although larger intervention groups were associated with lower phonemic outcomes in the TIP condition, group size did not influence end-of-kindergarten reading outcomes in the ESC condition. For every one fewer student in a TIP group, students performed approximately 0.38 *SD* units higher on the phonemic awareness outcome construct. Conversely, group size had virtually no influence on phonemic outcomes in the ESC condition (0.05 *SD* unit gain on latent phonemic scores). It is important to note that this study did not test for an optimal group size for kindergarten reading intervention.

Limitations

This study's findings must be considered in light of its limitations. The first pertains to measurement. The student model's phonemic awareness predictor was composed of a single measure, CTOPP SM (Wagner et al., 1999). Composite scores derived from the entire battery of CTOPP kindergarten measures may have provided a more complete account of children's entry-level phonemic awareness. A second potential measurement limitation model is that teachers' phonemic knowledge was sampled with a limited number of items. A measure broader in scope with more items may have provided a better account of teachers' knowledge of early literacy. Yet another potential measurement limitation is our selection of variables for each contextual model. Although we used prior research as a guide for identifying specific variables within each model, other dimensions of student, teacher, and setting contexts can influence outcomes (e.g., students' social behavior and home lives, teachers' interpersonal skills with students, school resources and supports). Future studies that include additional variables within these contexts may advance the field by identifying more potentially alterable variables that influence student response. A fourth potential limitation is sample size. Given that interaction and moderation tests tend to have relatively low statistical power, a larger sample size may have been required to detect this type of effect (Aiken & West, 1991; Cohen, Cohen, West, & Aiken, 2003). Studies with a larger number of student participants or that randomize at the student level (instead of the small-group level) could be informative. Furthermore, larger studies involving a greater number of teachers and instructional groups may also be particularly informative for studying the teacher and setting contexts. Finally, investigations that examine longer periods may provide more information about the durability of effects. Future research should include studies that examine the longitudinal influence of contextual variables across multiple years.

Implications and Conclusions

As the field continues to emphasize the provision of early reading intervention, the importance of understanding variables that influence young learners' reading achievement increases. Findings from this study corroborate Mosenthal's

(1984) contextual theory. That is, a partially specified set of factors from multiple contexts influenced at-risk children's reading performance. Student, teacher, and instruction variables were all related to the end-of-kindergarten reading performance of children who were identified as at risk for reading problems and received supplemental reading intervention.

In some cases, our findings replicate those of other researchers. For example, we found that entry-level student characteristics, such as letter knowledge and RAN, were once again strong predictors of student response. We also found some associations between smaller group sizes and stronger phonemic awareness outcomes in the TIP condition. Despite broad agreement in the literature that supplementary reading intervention should be delivered in small groups, few studies have examined the relation of group size and response to early reading intervention (Scammacca et al., 2007). In reading intervention models, where both pullout interventions and smaller group sizes are resource intensive, further research is needed to validate the importance of these alterable setting variables.

In the case of teacher and setting variables, our findings contribute new evidence to areas in which there is less research and less consistent findings. Specifically, results indicating that the models containing quality of teachers' instructional practices and setting variables explained at least as much variability in kindergarten reading outcomes as the model with students' entry-level language and literacy skills suggest that future research should continue to include these variables when examining supplemental early intervention. Furthermore, our findings that the influences of certain student, teaching, and setting variables on student outcomes may be moderated by type of beginning reading intervention should be examined in future studies. For example, it may be that highly specified interventions are more robust to variability in some contextual factors, such as teacher quality and group size.

In conclusion, the findings of this study underscore the complexity of understanding the effects of beginning reading interventions. Moreover, they identify that the influence of some learner characteristics can be attenuated by intervention features. Future research should strive to unpack and make sense of this complexity in ways that provide support to practitioners who need to make ongoing decisions about how to best provide and adjust intervention supports to students experiencing reading difficulties.

Declaration of Conflicting Interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: The intervention curriculum in this study was The Early Reading Intervention (Pearson/Scott Foresman, 2004). Because this manuscript's second and fourth authors (i.e., Coyne & Simmons) are also coauthors of the curriculum, the following steps were taken to ensure objectivity of findings: First, all data analyses were conducted by statisticians with no financial interest with The Early Reading Intervention program. In addition, an external consultant with no financial affiliations with the curriculum independently reviewed the manuscript to ensure that (a) data analyses were appropriate, accurate, and objective; (b) reported findings and discussion were accurate; and (c) interpretations were consistent with data analyses.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: Preparation of this article was supported in part by The Early Reading Intervention Project (Grant No. R324E060067A), a grant funded by the Institute of Education Sciences. This material does not necessarily represent the policy of the U.S. Department of Education, nor is it necessarily endorsed by the federal government. Please address correspondence to Dr. Shanna Hagan-Burke (shaganburke@tamu.edu), Department of Educational Psychology, College of Education and Human Development, 4225 Texas A&M University, College Station, TX 77843.

References

Aiken, L. S., & West, S. G. (1991). *Multiple regression: Testing and interpreting interaction*. Newbury Park, CA: Sage.

Al Otaiba, S., & Fuchs, D. (2002). Characteristics of children who are unresponsive to early literacy intervention: A review of the literature. *Remedial and Special Education*, *23*, 300–316. doi: 10.1177/07419325020230050501

Al Otaiba, S., & Fuchs, D. (2006). Who are the young children for whom best practices in reading are ineffective? An experimental and longitudinal study. *Journal of Learning Disabilities*, *39*, 414–431. doi:10.1177/00222194060390050401

Bohn, C. M., Roehrig, A. D., & Pressley, M. (2004). The first days of school in the classrooms of two more effective and four less effective primary-grades teachers. *Elementary School Journal*, *104*, 269–287. doi:10.1086/499753

Brady, S., Gillis, M., Smith, T., Lavalette, M., Liss-Bronstein, L., Lowe, E., . . . Wilder, T. D. (2009). First grade teachers' knowledge of phonological awareness and code concepts: Examining gains from an intensive form of professional development and corresponding teacher attitudes. *Reading and Writing*, *22*, 425–455. doi:10.1007/s11145-009-9166-x

Brophy, J. E. (1982). Successful teaching strategies for the inner city child. *Phi Delta Kappan*, *63*, 527–530.

Brophy, J. (1987). Synthesis of research on strategies for motivating students to learn. *Educational Leadership*, *45*(2), 40–48.

Brownell, M. T., Bishop, A. G., Gersten, R., Klingner, J. K., Penfield, R. D., Dimino, J., . . . Sindelar, P. T. (2009). The role of domain expertise in beginning special education teacher quality. *Exceptional Children*, *75*, 391–411.

Cavanaugh, C. L., Kim, A.-H., Wanzek, J., & Vaughn, S. (2004). Kindergarten reading interventions for at-risk students: Twenty years of research. *Learning Disabilities: A Contemporary Journal*, *2*(1), 9–21.

Chard, D. J., Stoolmiller, M., Harn, B. A., Wanzek, J., Vaughn, S., Linan-Thompson, S., & Kame'enui, E. J. (2008). Predicting reading success in a multilevel schoolwide reading model: A retrospective analysis. *Journal of Learning Disabilities*, *41*, 174–188. doi:10.1177/0022219407313588

Cheesman, E. A., McGuire, J. M., Shankweiler, D., & Coyne, M. (2009). First-year teacher knowledge of phonemic awareness and its instruction. *Teacher Education and Special Education*, *32*, 270–289.

Cirino, P. T., Pollard-Durodola, S. D., Foorman, B. R., Carlson, C. D., & Francis, D. J. (2007). Teacher characteristics, classroom instruction, and student literacy and language outcomes in bilingual kindergartners. *Elementary School Journal*, *107*, 341–364. doi:10.1086/516668

Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2003). *Applied multiple regression/correlation analysis for the behavioral sciences* (3rd ed.). Mahwah, NJ: Lawrence Erlbaum.

Dunn, L. M., & Dunn, L. M. (1997). *Peabody Picture Vocabulary Test–Third Edition (PPVT-III)*. Bloomington, MN: Pearson Assessments.

Evertson, C. M., Emmer, E. T., & Brophy, J. E. (1980). Predictors of effective teaching in junior high mathematics classrooms. *Journal for Research in Mathematics Education*, *11*, 167–178. doi:10.2307/748938

Foorman, B. R., Francis, D. J., Fletcher, J. M., Schatschneider, C., & Mehta, P. (1998). The role of instruction in learning to read: Preventing reading failure in at-risk children. *Journal of Educational Psychology*, *90*, 37–55.

Foorman, B. R., & Moats, L. C. (2004). Conditions for sustaining research-based practices in early reading instruction. *Remedial and Special Education*, *25*, 51–60. doi:10.1177/07419325040250010601

Foorman, B. R., & Torgesen, J. (2001). Critical elements of classroom and small-group instruction promote reading success in all children. *Learning Disabilities Research and Practice*, *16*, 203–212. doi:10.1111/0938-8982.00020

Gersten, R., Compton, D., Connor, C. M., Dimino, J., Santoro, L., Linan-Thompson, S., & Tilly, W. D. (2009). *Assisting students struggling with reading: Response to intervention and multi-tier intervention in the primary grades. A practice guide* (NCEE 2009–4045). Washington, DC: National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences, U.S. Department of Education. Retrieved from http://ies.ed.gov/ncee/wwc/publications/practiceguides/

Goe, L. (2007). *The link between teacher quality and student outcomes: A research synthesis*. Washington, DC: National Comprehensive Center for Teacher Quality. Retrieved from http://www.tqsource.org/link.php

Goe, L., & Stickler, L. M. (2008). *Teacher quality and student achievement: Making the most of recent research* (TQ Research and Policy Brief). Washington, DC: National Comprehensive Center for Teacher Quality. Retrieved from http://www.tqsource.org/publications/March2008Brief.pdf

Good, R. H., & Kaminski, R. A. (Eds.). (2002). *Dynamic Indicators of Basic Early Literacy Skills* (6th ed.). Eugene, OR: Institute for the Development of Educational Achievement.

Grace, D. P. (1986). *Patterns of effective mathematics teaching for low-achieving high school students in beginning algebra classes: An aptitude treatment interaction study* (Unpublished doctoral dissertation). University of Oregon, Eugene.

Greenwald, R., Hedges, L. V., & Laine, R. D. (1996). The effect of school resources on student achievement. *Review of Educational Research*, *66*, 361–396. doi:10.3102/00346543066003361

Greenwood, C. R., Delquadri, J. C., & Hall, R. V. (1984). Opportunity to respond and student academic achievement. In W. L. Heward, T. E. Heron, D. S. Hill, & J. Trap-Porter (Eds.), *Focus on behavior analysis in education* (pp. 58–88). Columbus, OH: Merrill.

Heck, R. H. (2007). Examining the relationship between teacher quality as an organizational property of schools and students' achievement and growth rates. *Educational Administration Quarterly*, *43*, 399–432. doi:10.1177/0013161X07306452

Hedges, L. V., & Olkin, I. (1985). *Statistical methods for meta analysis*. San Diego, CA: Academic Press.

Lyon, G. R., & Moats, L. C. (1997). Critical conceptual and methodological considerations in reading intervention research. *Journal of Learning Disabilities*, *30*, 578–588. doi:10.1177/002221949703000601

McCutchen, D., Abbott, R. D., Green, L. B., Beretvas, S. N., Cox, S., Potter, N. S., . . . Gray, A. L. (2002). Beginning literacy: Links among teacher knowledge, teacher practice, and student learning. *Journal of Learning Disabilities*, *35*, 69–86. doi:10.1177/002221940203500106

Mosenthal, P. (1983). The influence of social situation on children's classroom comprehension of text. *Elementary School Journal*, *83*, 537–547. doi:10.1086/461332

Mosenthal, P. (1984). The problem of partial specification in translating reading research into practice. *Elementary School Journal*, *85*, 199–227. doi:10.1086/461401

Muthén, L. K., & Muthén, B. O. (1998–2007). *Mplus user's guide* (5th ed.). Los Angeles, CA: Muthén & Muthén.

Nelson, J. R., Benner, G. J., & Gonzalez, J. (2003). Learner characteristics that influence the treatment effectiveness of early literacy interventions: A meta-analytic review. *Learning Disabilities Research and Practice*, *18*, 255–267. doi:10.1111/1540-5826.00080

Nougaret, A. A., Scruggs, T. W., & Mastropieri, M. A. (2005). Does teacher education produce better special education teachers? *Exceptional Children*, *71*, 217–229.

Pearson/Scott Foresman. (2004). *Scott Foresman Sidewalks: Early reading intervention*. Glenview, IL: Author.

Rice, J. K. (2003). *Teacher quality: Understanding the effectiveness of teacher attributes*. Washington, DC: Economic Policy Institute.

Rieth, H. J., & Evertson, C. M. (1988). Variables related to the effective instruction of difficult-to-teach children. *Focus on Exceptional Children*, *20*, 1–8.

Rivkin, S. G., Hanushek, E. A., & Kain, J. F. (2005). Teachers, schools, and academic achievement. *Econometrica*, *73*, 417–458. doi:10.1111/j.1468-0262.2005.00584.x

Rockoff, J. E. (2004). The impact of individual teachers on student achievement: Evidence from panel data. *American Economic Review*, *94*, 247–252. doi:10.1257/0002828041302244

Rosenshine, B. V. (1986). Synthesis of research on explicit teaching. *Educational Leadership*, *43*(7), 60–69.

Rosenshine, B., & Stevens, R. (1986). Teaching functions. In M. C. Witrock (Ed.), *Handbook on research and teaching* (3rd ed., pp. 376–390). New York, NY: Macmillan.

Rowan, B., Correnti, R., & Miller, R. J. (2002). What large-scale survey research tells us about teacher effects on student achievement: Insights from the *Prospects* study of elementary schools. *Teachers College Record*, *104*, 1525–1567.

Sanford, J. P., & Evertson, C. M. (1981). Classroom management in a low SES junior high: Three case studies. *Journal of Teacher Education*, *32*(1), 34–38. doi:10.1177/002248718103200108

Scammacca, N., Vaughn, S., Roberts, G., Wanzek, J., & Torgesen, J. K. (2007). *Extensive reading interventions in grades K–3: From research to practice*. Portsmouth, NH: RMC Research Corporation, Center on Instruction.

Schatschneider, C., Fletcher, J. M., Francis, D. J., Carlson, C. D., & Foorman, B. R. (2004). Kindergarten prediction of reading skills: A longitudinal comparative analysis. *Journal of Educational Psychology*, *96*, 265–282. doi:10.1037/0022-0663.96.2.265

Simmons, D. C., Coyne, M. D., Hagan-Burke, S., Kwok, O., Simmons, L., Johnson, C., . . . Crevecoeur, Y. C. (2011). Effects of supplemental reading interventions in authentic contexts: A comparison of kindergarteners' response. *Exceptional Children, 77*, 207–228.

Sindelar, P. T., Gartland, D., & Wilson, R. J. (1984). The effects of lesson format on the acquisition of mathematical concepts by fourth graders. *Journal of Educational Research*, *78*, 40–44.

Storch, S. A., & Whitehurst, G. J. (2002). Oral language and code-related precursors to reading: Evidence from a longitudinal structural model. *Developmental Psychology*, *38*, 934–947. doi:10.1037/0012-1649.38.6.934

Wagner, R. K., Torgesen, J. K., & Rashotte, C. A. (1999). *Comprehensive Test of Phonological Processing*. Austin, TX: PRO-ED.

Weade, R., & Evertson, C. M. (1988). The construction of lessons in effective and less effective classrooms. *Teaching and Teacher Education*, *4*, 189–213. doi:10.1016/0742-051X(88)90001-7

West, S. G., Finch, J. F., & Curran, P. J. (1995). Structural equation models with nonnormal variables: Problems and remedies. In R. H. Hoyle (Ed.), *Structural equation modeling: Concepts*, *issues and applications* (pp. 56–75). Thousand Oaks, CA: Sage.

Woodcock, R. W. (1998). *Woodcock Reading Mastery Tests–Revised/Normative Update*. Bloomington, MN: Pearson Assessments. (Original work published 1987)