



Characterizing the knowledge of educators across the tiers of instructional support

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Abstract

Translating the research base on effective reading instruction to the classroom has been a challenge. The delivery of these instructional methods requires practical skills coupled with an understanding of the aspects of language being taught. The purpose of this study was to explore the level of literacy knowledge of the English language held by educators who provide instruction to students in the primary grades. Data from 1369 classroom teachers, 74 reading interventionists, and 131 special educators comprising the analytic sample were collected as part of a training initiative in a US state. Participating educators completed a 50-item test of phonological sensitivity, phonemic awareness, decoding, encoding, and morphology. Multiple regression analyses confirmed differences in the levels of knowledge observed between the groups of educators. Reading interventionists demonstrated greater knowledge than classroom teachers and special educators in the total proportion of correct responses and across each domain. Classroom teachers demonstrated greater knowledge than special educators in phonological sensitivity and decoding but did not differ from each other in phonemic awareness, encoding, or morphology knowledge. Special educators provide intervention to students with the most severe forms of reading disabilities, yet they had the lowest level of knowledge. In contrast, reading interventionists, who provide intervention within general education, had the highest levels of knowledge. These findings suggest a need to elevate the knowledge of special educators and consider reading interventionists' role in supporting students identified with a specific learning disability in reading.

Keywords Intervention · Literacy · Special education · Teacher knowledge · Tiered instruction

Research into effective reading instruction has been plentiful and has long been used to inform public policy (Foorman & Nixon, 2006; Pressley et al., 2004). For example, the 2004 reauthorization of the Individuals with Disabilities Education Act in the United States (US) outlined an alternative approach to delivering instruction and intervention – Response to Intervention (RTI). The inclusion of RTI in this policy was motivated in part by reading research demonstrating the potential of RTI to positively impact students' reading outcomes

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through the early identification of students at-risk for reading failure coupled with the provision of evidence-informed instruction and intervention across tiers of instructional support within general education (Al Otaiba & Petscher, 2020; Fletcher et al., 2019; Fuchs & Fuchs, 2006; Fuchs & Vaughn, 2012). Implementing research-informed instruction and intervention through this framework serves to characterize students' response to differentiated instruction driven by the continual monitoring of their reading skills. Doing so also flags those students who experience persistent reading difficulties in response to evidence-informed instruction and intervention, which can complement traditional approaches to the identification of students with learning disabilities and determination of eligibility for special education as part of a hybrid identification model (Fletcher et al., 2019; Miciak & Fletcher, 2020; Odegard et al., 2020).

While the research base on effective instruction is plentiful, the translation of this research into practice continues to be a real challenge, and educators have struggled to implement evidence-informed practices effectively (Arden et al., 2017; Berkley et al., 2020). For example, in a 2015 evaluation of RTI, Balu and colleagues found a considerable amount of variance in the efficacy of RTI across schools. They recognized the false identification of students in need of intervention, a mismatch between intervention and students' needs, and poor alignment between core instruction and intervention as plausible factors that led to adverse effects. These identified obstacles have led to the failure of educators to implement RTI and point to a fundamental inability of teachers that goes well beyond RTI — they did not know what to teach their students nor how to go about teaching them (Binks-Cantrell et al., 2012a, 2012b). Such fundamental inability on the part of teachers to deliver instruction point to the crucial need for knowledge of the language being taught (i.e., what to teach) as well as knowledge of the methods most appropriate for teaching students to read it (i.e., how to teach it) (Gersten et al., 2020; Tolman, 2017).

Indeed, teachers' knowledge of the language they are trying to teach their students to read has long been identified as a core obstacle standing in the way of translating research into practice (Harper & Rennie, 2009; Lyon & Weiser, 2009; Moats, 1994). The ability of classroom teachers to deliver empirically validated reading instruction and intervention is supported by their explicit knowledge of the language they are striving to teach, known as academic content knowledge, and their knowledge of instructional methods, or pedagogical knowledge (Binks-Cantrell, et al., 2012a, 2012b; Carlisle et al., 2011; Spear-Swerling et al., 2005; Stark et al., 2016). Sadly, research has continued to document classroom teachers' lack of this knowledge (Foorman & Moats, 2004; Joshi & Wijekumar, 2019).

The consensus from the extant research is that teachers lack knowledge of the structure of the language that they are striving to teach their students to read and to write. In addition to the tacit, implicit knowledge of a language, educators must also possess explicit, declarative knowledge of the English language (Andrews & McNeill, 2005; Spear-Swerling & Cheesman, 2012). Declarative knowledge of the language is not a guaranteed by-product of being a proficient reader. A lack of declarative knowledge hinders an educator's ability to explain to their student how the language is structured and works — making it challenging for a teacher to identify instructional targets based on students' needs, select appropriate examples, and provide accurate corrective feedback to students (Andrews, 2007). An ability to do these things is required when teachers attempt to instruct their students using the forms of explicit instruction identified as being crucial for effective reading instruction in the early grades (Archer & Hughes, 2011; Foorman et al., 2016; Spear-Swerling & Cheesman, 2012). Thus, teacher academic content knowledge is a critical element needed to teach all students how to read and it has been linked to student outcomes (Carlisle et al.,

2011; McCombes-Tolis & Spear-Swerling, 2011; Piasta et al., 2009; Spear-Swerling, 2009).

The provision of explicit instruction is most needed in the early grades when students must acquire foundational literacy skills to support them throughout school and life. Teachers who engage in best practices derived from research are expected to provide explicit instruction targeting core emergent literacy and reading skills (Hislam & Cajkler, 2005). Based on their review of published research, Foorman and her colleagues identified these skill areas to include academic language skills, phonemic awareness, letter-sound correspondences, decoding, spelling, regular and irregular high frequency words, fluency, and comprehension (Foorman et al., 2016).

While research may identify these areas as necessary instructional targets in the early grades, teachers lack declarative knowledge of them (Foorman & Moats, 2004; Moats, 1994; Spear-Swerling et al., 2005). Specifically, researchers have explored teachers' knowledge of many specific aspects of the English language. These aspects include speech sounds found within words and an awareness of the phonological structure of spoken language. A teacher's knowledge of the phonological structure of language supports explicit instruction in phonological awareness, but teachers are often observed to have limited knowledge in this area (Bos et al., 2001; Cunningham et al., 2004; Lyon & Weiser, 2009; McMahan et al., 2019). Additionally, researchers have explored educators' knowledge of the sound-symbol correspondences that govern the pronunciation of words in the English language. Children are explicitly taught these correspondences as part of phonics instruction, but research has consistently demonstrated that educators lack explicit knowledge of these relationships (McCutchen et al., 2002; McMahan et al., 2019; Piasta et al., 2009).

Another commonly explored area is teachers' understanding of spelling concepts in the English language's orthographic structure. Research consistently illustrates the benefits of directly teaching spelling concepts to support students' spelling skills and facilitate students' ability to read and write (Graham, 1999; Graham & Santangelo, 2014; Weiser & Mathes, 2011). Also, the morphological structure of language influences word reading and spelling and informs students of word meanings in support of vocabulary development and reading comprehension (Arrow et al., 2019; Binks-Cantrell, et al., 2012a, 2012b; Carreker et al., 2010; Rastle, 2019). However, teachers' lack of knowledge of spelling concepts and the English language's orthographic structure continues to be found (Carreker et al., 2010; McMahan et al., 2019). Educators have also shown pronounced deficits in their understanding of the morphological structure of the English language (Crim et al., 2008; McMahan et al., 2019).

Reading interventionists' and special educators' knowledge

The need for knowledge of the foundational components of the English language named above extends beyond classroom teachers to include the multiple layers of educators responsible for the delivery of research-informed differentiated instruction and intervention across the systems of support exemplified in educational frameworks such as RTI (Balu et al., 2015; Gersten et al., 2020; Tolman, 2017; Wanzek et al., 2019). In particular, reading interventionists and special education teachers are expected to support the identification of students in need of instructional support and intervention. Additionally, they are expected to deliver evidence-informed instruction and intervention to address the needs of these students (Bean et al., 2018). However, unlike classroom teachers, both reading

interventionists and special educators are tasked to intervene with the most severely learning-impaired students.

While the research on teacher knowledge is considerable and compelling, it primarily has focused on general educators (Brownell et al., 2020). Far less research has focused on the level of knowledge held by other groups of educators who support students across the multiple layers of support found within their schools. Literacy professionals are certified educators with specialized knowledge of reading who commonly deliver more intensive reading instruction and intervention to students who struggle to respond to the core reading instruction provided to them by their classroom teachers. Reading interventionists are one formal group of literacy professionals. Other literacy professionals include literacy coaches, literacy interventionists, reading specialists, and Title 1 reading teachers. In a national survey of specialized literacy professionals by Bean and colleagues (2015), reading interventionists reported that they spend most of their time instructing students, assessing students, analyzing data, and supporting teachers. In addition to working with students, reading interventionists often consult with teachers on reading strategies and work with the school-level RTI team (Bean et al., 2015). These multiple roles and responsibilities require these individuals to have a deep level of content knowledge to enact these expectations effectively. The need for advanced levels of reading content knowledge to be held by reading professionals working with all students, including students with reading difficulties, was recognized by the International Literacy Association (ILA) in its latest standards for preparing literacy professionals (Kern et al., 2018). A similar need is highlighted in the standards of the International Dyslexia Association (2018). To obtain a reading specialist endorsement, an endorsement commonly held by reading interventionists, educators complete additional graduate-level courses in literacy and pass the Praxis Reading Specialist Exam.

In contrast to reading interventionists, special educators must meet the needs of students who are eligible for services provided through special education. This means that they work with students who are determined to have more severe difficulties and did not make adequate progress within the tiered interventions provided in general education. The largest eligibility category for these services is a specific learning disability, and the most prevalent form of a specific learning disability is a reading disability (Fletcher et al., 2019). Yet, many special education training programs and much research about the individuals in and from them focus on instructional practices and interventions, pedagogical knowledge, rather than on domain-specific knowledge and skills, academic content knowledge (Brownell et al., 2020; Park et al., 2019). Brownell and colleagues (2009) explored the quality of special education teachers by assessing their literacy knowledge and its relationship to classroom practice. They found that beginning special education teachers have stronger classroom management skills and instructional practices than specific knowledge of how to teach reading (Brownell et al., 2009).

Moreover, when special educators instruct reading, they spend more time addressing certain areas than others. For example, Ciullo and colleagues (2019) conducted an observational study of special educators who worked with fourth- and fifth-grade students with learning disabilities. In their observations, they found that special educators spent most of their time on reading comprehension (31%) compared to phonics/word study (16%) and phonological awareness (1%). Yet, research highlights that children in special education present with deficits in reading comprehension and word reading and spelling skills (Odegard et al., 2020). As such, the efforts of special educators may not be appropriately targeting the deficits and needs of their students. However, within their training programs, special educators are not required to demonstrate knowledge of reading development, but rather a

priority is placed on the assessment of pedagogical knowledge (Stotsky, 2009). A special education endorsement can often be earned through the successful completion of graduate level courses without the requirement of a Praxis exam.

Of the existing empirical literature on teacher knowledge of reading, a vast majority of studies have focused on elementary classroom teachers with only three known studies including all three educator groups: classroom teachers, special educators, and reading interventionists. Moats (1994) surveyed a group of educators who chose to take a literacy course at local colleges. Her sample of 89 participants included reading teachers, classroom teachers, special education teachers, speech-language pathologists, classroom teaching assistants, and graduate students. She found that these educators do not have a sufficient understanding of reading and writing concepts to adequately teach beginning readers. These educators showed weak phonics and morphology skills. However, this data was not disaggregated by the educator's roles, so it is unknown whether some types of educators had higher levels of knowledge than others.

Bos et al. (2001) examined the literacy knowledge and perception of preparedness to teach reading in a group of preservice and inservice teachers. The inservice group included 181 classroom teachers, 44 special education teachers, 24 reading specialists or Title I reading teachers, 12 English as a second language (ESL) teachers, and 10 speech-language pathologists. Results indicated that both groups felt somewhat prepared to teach reading but lacked a basic knowledge of phonics and phonological awareness. Bos and her colleagues did compare classroom teachers' levels of knowledge against an aggregated group comprised of all other inservice educators, which they referred to as special educators. They found that this special educator group had significantly more knowledge than classroom teachers. However, the results were not further disaggregated to explore the levels of knowledge within the diverse special education group.

Finally, Folsom and colleagues (2017) studied the early literacy knowledge of K-3 educators before and after a series of professional development modules and trainings provided by the state department of education. Their sample included classroom teachers, special educators, literacy coaches, and administrators. Literacy coaches were educators employed by the state to support literacy instruction in high poverty schools in the state. The authors found that performance increased from the 48th to the 59th percentile on their online survey that examined knowledge of early literacy skills. However, they did not report the growth broken down by educator role. The different terms used for literacy professionals in these studies and the aggregated educator groups make it difficult to look across studies to determine the levels of literacy knowledge held by educators in different roles.

Purpose of the present study

Given the lack of research exploring the knowledge of special educators and reading interventionists, it is unclear to what extent educators who are tasked with supporting the instructional needs of struggling readers possess declarative knowledge of the English language. The present study was undertaken to examine the levels of basic literacy academic content knowledge held by licensed educators serving as classroom teachers, reading interventionists, and special educators. We hypothesize that educators tasked to work primarily with students who have the highest level of need (i.e., struggling readers and students with disabilities) would have the highest levels of teacher knowledge. Specifically, reading

interventionists and special educators would have more knowledge of literacy constructs than classroom teachers. This study addressed the following research questions:

Research question 1: Do classroom teachers, reading interventionists, and special education teachers differ in their overall literacy knowledge?

Research question 2: Do educators in different roles exhibit differences in knowledge in some areas of the English language, but not in other areas?

Both research questions were addressed using multiple regression analyses with educator role as a predictor variable. The total proportion correct on the knowledge test was the outcome variable in the model for research question one. A series of five models were then conducted with the proportion of correct responses for a given domain as the outcome variable to address research question two. All models included whether or not the educator had a master's degree or had a reading endorsement and years since certification as additional predictors to control for the potential impact of these prior experiences.

Method

Study design and participants

The data reported in this study were gathered from educators who taught in public schools located in a single southern US state. These data were obtained before these educators began a required training that was part of a statewide training initiative in Arkansas. Data were available for a total of 1673 licensed educators working in public elementary schools ($n=1460$ classroom teachers for grades K–2, $n=75$ reading interventionists, and $n=138$ special educators). Seven educators did not respond to at least one item on the knowledge test, and an additional 83 educators left a background item about years since receiving their certification blank. These individuals were dropped to avoid missingness on individual variables in analyses. As a result, the analytic sample included 1574 educators ($n=1369$ classroom teachers for grades K–2, $n=74$ reading interventionists, and $n=131$ special educators). There were no reliable differences in reports of having a master's degree or reading endorsement for individuals who were or were not included in the analytic sample, $\chi^2(1)=0.62, p=0.37$; $\chi^2(1)=0.06, p=0.81$.

The demographic and educational background characteristics for the full analytic sample ($N=1574$) and each educator group are in Table 1. All participating educators in the analytic sample had at least a bachelor's degree, and 676 also had a master's degree ($n=542$ classroom teachers, $n=47$ reading interventionists, $n=87$ special educators). In this state, beginning in 2017, all applicants for elementary education (K–6) or special education (K–12) licensure are required to pass a state reading assessment to demonstrate an understanding of reading and writing development based on scientific reading research, unless they began their licensure program after 2017. Forty-nine individuals received their initial certification within the past year based on when the data were collected in 2018 ($n=45$ classroom teachers, $n=1$ reading interventionist, $n=3$ special educators), and 25 reported receiving it 40 or more years ago ($n=20$ classroom teachers, $n=2$ reading interventionists, $n=3$ special educators). This information is used as a proxy for years of teaching experience. Further, to obtain a formal reading specialist endorsement from the state, educators are required to complete a course of study and pass the Reading Specialist Praxis test. Of the participating educators in the analytic sample, 155 held this formal state-level reading endorsement

Table 1 Participant demographic characteristics and scores on the knowledge test

Variables	Educator groups			
	Analytic sample (<i>N</i> = 1574)	Classroom teachers (<i>n</i> = 1369)	Reading interventionists (<i>n</i> = 74)	Special educators (<i>n</i> = 131)
	%	%	%	%
Gender (female)	95.20 ^a	94.70 ^b	100	96.90 ^c
Race and ethnicity				
African American	5.21	5.00	5.40	6.90
American Indian/Alaska Native	0.57	0.50	0.00	1.50
Asian	0.13	0.10	0.00	0.00
Hispanic	0.95	1.00	0.00	0.80
White not of Hispanic origin	87.74	87.70	90.5	86.30
Multiple races/ethnicities	1.27	1.10	2.70	2.29
Not reported	4.13	4.50	1.40	2.30
Master's degree	42.9	39.60	63.50	66.40
Reading endorsement	9.80	8.80	36.50	6.10
Special education endorsement	12.10	4.20	2.70	100
	<i>M</i> (<i>SE</i>)	<i>M</i> (<i>SE</i>)	<i>M</i> (<i>SE</i>)	<i>M</i> (<i>SE</i>)
Years since certification	14.16 (0.27)	13.68 (0.29)	21.19 (1.25)	15.19 (0.92)
Proportion correct on the knowledge test				
Total	.57 (0.00)	.57 (0.00)	.68 (0.02)	.54 (0.01)
Phonological sensitivity	.72 (0.00)	.73 (0.00)	.79 (0.02)	.68 (0.01)
Phonemic awareness	.66 (0.00)	.66 (0.01)	.77 (0.02)	.65 (0.02)
Decoding	.64 (0.00)	.64 (0.01)	.74 (0.02)	.59 (0.01)
Encoding	.48 (0.00)	.48 (0.00)	.60 (0.02)	.47 (0.01)
Morphology	.35 (0.01)	.34 (0.01)	.49 (0.03)	.33 (0.02)

^a*n* = 63 not reported

^b*n* = 62 not reported

^c*n* = 1 not reported

(*n* = 120 classroom teachers, *n* = 27 reading interventionists, *n* = 8 special educators). A similar procedure is used to obtain a formal special education endorsement from the state. In the analytic sample, 190 educators held the formal state-level special education endorsement (*n* = 57 classroom teachers, *n* = 2 reading interventionists, *n* = 131 special educators).

Statewide reports from this state's department of education website for the year in which our data were obtained indicated that across the entire state, 43% of teachers report their highest level of education to be a master's degree and that teachers have an average of 11.87 years of teaching experience. Table 1 shows that in the analytic sample as a whole (i.e., combining our three groups of educators), 42.9% of our participants have a master's degree, and they obtained their teaching certification an average of 14.16 years before taking part in this study. These values indicate our sample to be representative of educators across the state.

Knowledge test

The current study used a test developed by McMahan et al. (2019) that was based on prior surveys of teacher knowledge (e.g., Binks-Cantrell, et al., 2012a, 2012b; Bos et al., 2001; Moats, 1994). The knowledge test from McMahan et al. (2019) contains 50 items to assess five domains of basic knowledge of the English language: phonological sensitivity, phonemic awareness, decoding, encoding, and morphology. Phonological sensitivity is the awareness of parts of words larger than a phoneme, such as rhyme and syllable. Phonemic awareness is the knowledge of and ability to manipulate the smallest unit of sounds in speech. Decoding is the ability to match letters with sounds. Encoding is the ability to link sounds to letters in writing or spelling. Morphology refers to the study of the smallest units of meaning in language. Within each domain of knowledge, there were 10 multiple-choice questions that were all focused on academic content knowledge. Half of the questions in each domain required participants to define terms, such as phonological awareness, or identify instructional activities, such as phoneme deletion and phoneme manipulation. The remaining test items in each domain required participants to demonstrate their ability to perform a task, such as to count the number of phonemes in a word or identify where a word would be divided into syllables (see McMahan et al. (2019) for examples of test items).

McMahan et al. (2019) observed performance differences on this test between educators who were beginning training, had completed a 2-year training, or had completed a 2-year training and obtained a national certification after completing practicum requirements and a separate examination from national certifying organizations to become Certified Academic Language Therapists. The current study extends this prior work to examine performance on the knowledge test across educators who play different roles in public school settings. The reported Cronbach's alpha for the 50-item survey was 0.86 (McMahan et al., 2019), and it was 0.75 for the current analytic sample. In the analyses addressing the second research question, performance was investigated for each of the five domains covered on the test. The Cronbach's alpha obtained for each domain with the current data were somewhat lower than the value obtained across all 50 items (phonological sensitivity $\alpha=0.44$, phonemic awareness $\alpha=0.50$, decoding $\alpha=0.47$, encoding $\alpha=0.33$, morphology $\alpha=0.39$). Results using these separate domain scores should be interpreted with caution.

Procedures

The data were collected through an online learning management system maintained by the state's department of education. There was no time limit to complete the 50-item knowledge test, but the educators were required to complete this test before accessing the materials and beginning their required state training course. Educators also completed background items about their education and current role in schools. These data were de-identified and then shared as part of a data-sharing agreement between this state's department of education and the investigators.

Results

A series of multiple regression analyses were conducted to address the research questions using the `lm` command in R (R Core Team, 2020) with effect sizes for the contrast estimates calculated from the `emmeans` package (Lenth, 2020). All models included the same

set of predictors and varied in their outcome variable (see Table 2). The predictors were a categorical variable for the educator's role (i.e., classroom teacher, reading interventionist, or special educator), and separate dichotomous variables for whether the educator had a master's degree, or reading endorsement, or not. For these categorical and dichotomous variables, the reference category was the largest group of people (i.e., classroom teacher, bachelor's only, no reading endorsement). The final predictor in the models was the continuous variable of the number of years since the educator obtained their initial teaching certification, which serves as a proxy for years of teaching experience. For each model, effect size estimates for contrasts between groups of educators accounted for other predictors by averaging results across continuous scores (years since certification) or levels for categorical predictors (master's degree and reading endorsement).

Overall knowledge of literacy

Table 1 reports each group's performance on the knowledge test as a whole and across each domain. There were 39 educators who earned their initial teaching certificate, or had a knowledge test total score, or score from one or two domains on the knowledge test outside three standard deviations from the analytic sample mean. The analyses reported below were repeated without these potential outliers and revealed the same pattern of results. The first research question examined if educators who have different roles in schools exhibit differences in their overall knowledge of literacy as measured by the total proportion of correct responses on the knowledge test. This regression model was significant. The educator's background (i.e., possession of a master's degree and/or reading endorsement, and years since certification) were not significant. However, the impact of the educator's role was significant. The estimates in Table 2 illustrate that performance on the knowledge test differed for reading interventionists and special educators compared to classroom teachers, who served as the reference group. The estimates from the unstandardized coefficients in Table 2 indicate that when other variables are held constant, a reading interventionist's score on the knowledge test would be higher than that of a classroom teacher by 0.11 units.

Further, Cohen's d values were calculated for pairwise contrasts of the predicted values from the model for the groups of educators. After accounting for other predictors in the model, interventionists had higher scores than both teachers ($d=0.95$, $SE=0.12$) and special educators ($d=1.19$, $SE=0.15$) as illustrated by the large effect sizes associated with these contrasts. In contrast, there was a small effect such that classroom teachers' scores were higher than special educators' scores ($d=0.23$, $SE=0.09$).

Knowledge of literacy across domains

To address research question 2, separate regression models were analyzed using the proportion of correct responses for each domain from the knowledge test. The other predictors in these models were identical to the prior model.

Phonological sensitivity

The regression model for the proportion of correct responses to the phonological sensitivity items was significant. The educator's reports of additional training (i.e., possession of a master's degree and/or reading endorsement) were not significant. The impact of the number of years since the educator received their initial teaching certificate was significant.

Table 2 Summary of regression analyses predicting performance on the knowledge test

Variable	<i>B</i>	<i>SE</i>	<i>t</i>	<i>p</i>	95% CI
Total					
(Intercept)	0.56	0.01	108.09	< .001	[0.55, 0.57]
Reading interventionist	0.11	0.01	7.75	< .001	[0.08, 0.13]
Special educator	-0.03	0.01	-2.53	.012	[-0.05, -0.01]
Master's	0.01	0.01	1.53	.127	[-0.00, 0.02]
Reading endorsement	0.01	0.01	0.52	.600	[-0.01, 0.03]
Years since certification	0	0	0.74	.460	[-0.00, 0.00]
R^2	.05				
Adjusted R^2	.05				
$F(5, 1568)$	16.40			< .001	
Phonological sensitivity					
(Intercept)	0.73	0.01	102.98	< .001	[0.72, 0.75]
Reading interventionist	0.07	0.02	3.58	< .001	[0.03, 0.11]
Special educator	-0.05	0.01	-3.17	.002	[-0.07, -0.02]
Master's	0.01	0.01	1.21	.225	[-0.01, 0.03]
Reading endorsement	0.01	0.01	0.74	.459	[-0.02, 0.04]
Years since certification	0	0	-2.3	.021	[-0.00, -0.00]
R^2	.02				
Adjusted R^2	.02				
$F(5, 1568)$	6.32			< .001	
Phonemic awareness					
(Intercept)	0.66	0.01	83.74	< .001	[0.64, 0.67]
Reading interventionist	0.12	0.02	5.77	< .001	[0.08, 0.16]
Special educator	-0.01	0.02	-0.61	.541	[-0.04, 0.02]
Master's	0	0.01	-0.5	.620	[-0.02, 0.01]
Reading endorsement	-0.01	0.02	-0.66	.511	[-0.04, 0.02]
Years since certification	0	0	0.56	.576	[-0.00, 0.00]
R^2	.02				
Adjusted R^2	.02				
$F(5, 1568)$	7.22			< .001	
Decoding					
(Intercept)	0.62	0.01	78.94	< .001	[0.60, 0.63]
Reading interventionist	0.09	0.02	4.27	< .001	[0.05, 0.13]
Special educator	-0.05	0.02	-3.06	.002	[-0.08, -0.02]
Master's	0.01	0.01	1	.319	[-0.01, 0.03]
Reading endorsement	0.01	0.02	0.44	.660	[-0.02, 0.04]
Years since certification	0	0	2.52	.012	[0.00, 0.00]
R^2	.03				
Adjusted R^2	.02				
$F(5, 1568)$	8.72			< .002	
Encoding					
(Intercept)	0.46	0.01	64.96	< .001	[0.45, 0.48]
Reading interventionist	0.12	0.02	6.09	< .001	[0.08, 0.15]
Special educator	-0.02	0.01	-1.24	.217	[-0.05, 0.01]

Table 2 (continued)

Variable	<i>B</i>	<i>SE</i>	<i>t</i>	<i>p</i>	95% CI
Master's	0.02	0.01	2.33	.020	[0.00, 0.04]
Reading endorsement	0	0.01	-0.3	.763	[-0.03, 0.02]
Years since certification	0	0	1.24	.216	[-0.00, 0.00]
R^2	.03				
Adjusted R^2	.03				
F (5, 1568)	10.61			< .001	
Morphology					
(Intercept)	0.33	0.01	40.04	< .001	[0.32, 0.35]
Reading interventionist	0.14	0.02	6.42	< .001	[0.10, 0.19]
Special educator	-0.01	0.02	-0.65	.516	[-0.04, 0.02]
Master's	0.01	0.01	1.24	.214	[-0.01, 0.03]
Reading endorsement	0.02	0.02	1.46	.143	[-0.01, 0.06]
Years since certification	0	0	0.31	.760	[-0.00, 0.00]
R^2	.04				
Adjusted R^2	.03				
F (5, 1568)	11.25			< .001	

CI confidence interval

Educators who received their initial teaching certification more recently had higher scores. However, the estimates for the unstandardized coefficients in Table 2 indicate that this is a very small effect because when other predictors in the model are held constant, a difference in obtaining a teaching certificate by 1 year changes the knowledge test performance by less than 0.00. Furthermore, when predicted values are calculated, the estimates indicate that holding all other variables constant, the average classroom teacher with a bachelor's degree and no reading endorsement who obtained their teaching certificate within the past year has a proportion correct on the knowledge test of 0.73 (95% CI [0.72, 0.75]). In contrast, a person with the same qualifications who obtained their teaching certificate 30 years ago would have a score of 0.71 (95% CI [0.69, 0.72]).

There was a significant effect for the educator's role. After accounting for other predictors in the model, reading interventionists had higher scores than both teachers ($d=0.44$, $SE=0.12$) and special educators ($d=0.73$, $SE=0.15$) as illustrated by the small to medium effect sizes associated with these contrasts. There was also a small effect such that classroom teachers' scores were higher than those of special educators ($d=0.29$, $SE=0.09$).

Phonemic awareness

The regression model for the proportion of correct responses to the phonemic awareness items was significant. The educator's reports of additional training (i.e., possession of a master's degree and/or reading endorsement) and years since certification were not significant, but the effect of the educator's role was (see Table 2). After accounting for other predictors in the model in the same manner described above, reading interventionists had higher scores than both teachers ($d=0.71$, $SE=0.12$) and special educators ($d=0.76$, $SE=0.15$) as illustrated by the medium effect sizes associated with these contrasts. There

was no significant difference between the scores of classroom teachers and special educators ($d=0.06$, $SE=0.09$).

Decoding

The regression model for the proportion of correct responses to the decoding items was significant. The educator's reports of additional training (i.e., possession of a master's degree and/or reading endorsement) were not significant. There was a small effect for years since certification such that educators who obtained their initial teaching certification more recently had higher scores (see Table 2). Furthermore, there was a significant effect for the educator's role. After accounting for other predictors in the model as described previously, interventionists had higher scores than both teachers ($d=0.52$, $SE=0.12$) and special educators ($d=0.81$, $SE=0.15$) as illustrated by medium and large effect sizes. There was also a small effect such that classroom teachers' scores were higher than those of special educators ($d=0.28$, $SE=0.09$).

Encoding

The regression model for the proportion of correct responses to the encoding items was significant. There was a small effect such that educators with a master's degree had higher performance on these encoding items than those with only a bachelor's degree (see Table 2). There was a significant effect for the educator's role. After accounting for other predictors in the model, reading interventionists had higher scores than both teachers ($d=0.75$, $SE=0.12$) and special educators ($d=0.86$, $SE=0.15$) with large effect sizes for these contrasts. Classroom teachers' and special educators' scores did not significantly differ ($d=0.12$, $SE=0.09$).

Morphology

The regression model for the proportion of correct responses to the morphology items was significant. The only significant effect involved the educator's role (see Table 2). After accounting for other predictors in the model in the same way as all previous models, interventionists had higher scores than both teachers ($d=0.79$, $SE=0.12$) and special educators ($d=0.85$, $SE=0.15$) as illustrated by the large effect sizes. There was no significant difference between the scores for classroom teachers and special educators ($d=0.06$, $SE=0.09$).

Discussion

This study examined the basic literacy knowledge and skills of classroom teachers, reading interventionists, and special education teachers. The basic literacy constructs of phonological sensitivity, phonemic awareness, decoding, encoding, and morphology are essential knowledge and skills for any educator who works with students, particularly struggling readers (Cunningham et al., 2004; Foorman & Moats, 2004; Moats, 1994). With the implementation of RTI and multi-tiered systems of support (MTSS) frameworks, more educators are being called upon to provide intensive interventions for students in general education and special education. Therefore, these educators must understand the constructs of the language they are asked to teach. This study was designed to explain the levels of academic

content knowledge of foundational reading skills for three groups of educators involved in the RTI and related frameworks, an area lacking in the current body of teacher knowledge research. We hypothesized that the educators whose primary responsibility is to work with struggling readers with the highest needs would have the highest levels of literacy knowledge.

Our results partially support our hypothesis. Reading interventionists who are literacy professionals that provide reading intervention within the more intense tiers in general education settings had the highest level of literacy knowledge across all five constructs compared to classroom and special education teachers. This finding is not surprising given the standards for reading professionals established by professional organizations and adopted by many districts that emphasize the importance of a strong foundational knowledge of reading (International Dyslexia Association, 2018; International Literacy Association, 2010). What is surprising, and contrary to our predictions is that special educators lacked specialized knowledge of the English language. The special education teachers, who are tasked with providing the most intensive interventions to students with the most severe reading difficulties, consistently had knowledge levels at or below both reading interventionists and classroom teachers. These findings are not meant to imply that special education teachers are not literate but that they may lack declarative knowledge of aspects of the English language needed to teach reading.

This demonstration of limited academic content knowledge of reading can have far-reaching impacts on the most vulnerable readers. Without this knowledge, special educators may “misinterpret assessments, choose inappropriate examples of words for instruction, provide unintentionally confusing instruction, or give inappropriate feedback to children’s errors” (Spear-Swerling et al., 2005, p. 267–268). They may be unable to break down reading processes and provide the explicit instruction needed by students with disabilities (Park et al., 2019; Washburn & Mulchay, 2014). Special educators are also tasked with setting individualized learning goals for each student. Knowledge of basic literacy constructs could support teachers in writing appropriate, measurable goals for their students.

Perhaps special educators’ limited knowledge of academic content knowledge can be attributed to the broad approaches taken to prepare preservice teachers’ for special education roles. Brownell et al. (2020) noted that it was difficult to draw conclusions from special education teacher preparation studies because of the variation in focus, experiences, and outcomes of the different programs. They also report that the focus on pedagogical practice has left little space for developing the knowledge that special educators need for identifying students’ needs and appropriate instruction. Rethinking the scope of teacher preparation programs to include coursework focused on building academic content knowledge alongside building pedagogical content knowledge could better equip special educators to meet the needs of students with the highest literacy needs.

The results of this study must be interpreted in light of a few limitations. First, the administration of the test was online. Although online testing has become more commonplace in research, there are still concerns that participants may have referenced other sources of knowledge to answer the questions. However, given the overall performance on the test was relatively weak, it would appear that teachers were not seeking out information from other sources to answer the questions successfully. Of course, this heightens other concerns that teachers were not fully engaging in the task. However, the overall performance on the test of knowledge used in this study is comparable to the performance observed in a separate study using the same instrument where the test was administered by having participants fill in physical copies in a controlled setting (McMahan et al., 2019).

A second limitation of the study is the scope of the aspects of language captured on the knowledge test used and the lower inter-item reliability estimates for the individual domain scores. There is growing awareness that the needs of struggling readers in the primary grades are not limited to just the aspects of language captured on the test used in this study and many other studies of teacher knowledge. For example, Odegard and his colleagues (2020) used universal screening data from a larger sample of second-grade students receiving services across the tiers of instruction in general and special education. They observed the most common profile of reading deficits to be a mixed profile. Struggling readers experienced deficits in print concepts captured in the current study (word reading and spelling) and comprehension areas (reading comprehension and vocabulary) that were not captured in the present study. This mixed profile of deficits was observed in children being served in the general education setting, students identified with characteristics of dyslexia, and students classified with a specific learning disability. This pattern of findings would suggest that all of the educators included in the current study, classroom teachers, reading interventionists, and special educators need knowledge of more than just the language constructs assessed in the present study. This limitation is true of the overall literature on teacher knowledge. Furthermore, this study and the extant literature have focused more on academic content than pedagogical knowledge of these literacy skills. Thus, motivating future studies on educator pedagogical knowledge.

The data for the study was collected from a single state and therefore limits the generalizability of the findings beyond the current sample. Despite the analytic sample including teachers in three separate educator roles, factors such as where educators were trained or the influence of professional development or training experiences were not considered. Yet, small to negligible results were found in regards to whether the educators had an advanced degree or the number of years since they became certified. Future research could continue to explore the impact of other aspects of the educator's training on their knowledge performance and if our findings hold across other samples.

Given the pattern of knowledge deficits observed in this study, efforts to expand the domains of knowledge explored should also expand who comprises the studied samples to include special educators and the more commonly studied general educators. Although previous research has established the lack of knowledge of basic literacy constructs for classroom teachers, few studies have addressed the literacy knowledge of educators presumed to have more specialized knowledge and tasked to provide intervention to struggling readers. This study adds to this body of knowledge by suggesting that educators in different positions have varying levels of literacy knowledge. In light of the MTSS/RTI framework, which establishes tiers of increasingly intensive support, struggling readers may not be receiving that support from teachers with higher levels of literacy knowledge. Efforts are needed to increase the critical knowledge in all literacy domains of all educators working with struggling readers, including special education teachers. Professional development and teacher preparation programs must ensure that all teachers are prepared with the necessary literacy knowledge and skills required to meet the needs of all struggling readers.

References

- Al Otaiba, S., & Petscher, Y. (2020). Identifying and serving students with learning disabilities, including dyslexia, in the context of multitiered supports and response to intervention. *Journal of Learning Disabilities, 53*(5), 317–331. <https://doi.org/10.1177/0022219420943691>

- Andrews, S. (2007). Teacher language awareness. *Cambridge University Press*. <https://doi.org/10.1017/CBO9780511497643>
- Andrews, S., & McNeill, A. (2005). Knowledge about language and the 'good language teacher.' In N. Batels (Ed.), *Applied linguistics and language teacher education* (pp. 159–178). Springer.
- Archer, A. L., & Hughes, C. A. (2011). *Explicit instruction: Effective and efficient instruction*. Guildford Press.
- Arden, S. V., Gandhi, A. G., Edmonds, R. Z., & Danielson, L. (2017). Toward more effective tiered systems: Lessons from national implementation efforts. *Exceptional Children*, 83(3), 269–280. <https://doi.org/10.1177/0014402917693565>
- Arrow, A., Braid, C., & Chapman, J. (2019). Explicit linguistic knowledge is necessary, but not sufficient for the provision of explicit literacy instruction. *Annals of Dyslexia*, 69, 21–33. <https://doi.org/10.1007/s11881-018-00168-0>
- Balu, R., Zhu, P., Doolittle, F., Schiller, E., Jenkins, J., & Gersten, R. (2015). *Evaluation of response to intervention practices for elementary school reading*. National Center for Education Evaluation and Regional Assistance, Institute for Educational Sciences, U.S. Department of Education. <https://ies.ed.gov/pubsearch/pubsinfo.asp?pubid=NCEE20164000>
- Bean, R. M., Dagen, A. S., Ippolito, J., & Kern, D. (2018). Principals' perspectives on the roles of specialized literacy professionals. *The Elementary School Journal*, 119(2), 327–350. <https://doi.org/10.1086/700280j>
- Bean, R. M., Kern, D., Goatley, V., Ortlieb, E., Shettel, J., Calo, K., Marinak, B., Sturtevant, E., Elish-Piper, L., L'Allier, S., Cox, M. A., Frost, S., Mason, P., Quatroche, D., & Cassidy, J. (2015). Specialized literacy professionals as literacy leaders: Results of a national survey. *Literacy Research and Instruction*, 54(2), 83–114. <https://doi.org/10.1080/19388071.2014.998355>
- Berkley, S., Scanlon, D., Bailey, T. R., Sutton, J. C., & Sacco, D. M. (2020). A snapshot of rti implementation a decade later: New picture, same story. *Journal of Learning Disabilities*, 53(5), 332–342. <https://doi.org/10.1177/0022219420915867>
- Binks-Cantrell, E., Joshi, R. M., & Washburn, E. K. (2012a). Validation of an instrument for assessing teacher knowledge of basic language constructs of literacy. *Annals of Dyslexia*, 62, 153–171. <https://doi.org/10.1007/s11881-012-0070-8>
- Binks-Cantrell, E., Washburn, E. K., Joshi, R. M., & Hougen, M. (2012b). Peter effect in the preparation of reading teachers. *Scientific Studies of Reading*, 16(6), 526–536. <https://doi.org/10.1080/10888438.2011.601434>
- Bos, C., Mather, N., Dickson, S., Podhajski, B., & Chard, D. (2001). Perceptions and knowledge of preservice and inservice educators about early reading instruction. *Annals of Dyslexia*, 51, 97–120. <https://doi.org/10.1007/s11881-001-0007-0>
- Brownell, M. T., Bishop, A. G., Gersten, R., Klingner, J. K., Penfield, R. D., Dimino, J., Haager, D., Menon, S., & Sindelar, P. T. (2009). The role of domain expertise in beginning special education teacher quality. *Exceptional Children*, 75(4), 391–411. <https://doi.org/10.1177/001440290907500401>
- Brownell, M. T., Jones, N. D., Sohn, H., & Stark, K. (2020). Improving teacher quality for students with disabilities: Establishing a warrant for teacher education practice. *Teacher Education and Special Education*, 43(1), 28–44. <https://doi.org/10.1177/0888406419880351>
- Carlisle, J., Kelcey, B., Rowan, B., & Phelps, G. (2011). Teachers' knowledge about early reading: Effects on students' gains in reading achievement. *Journal of Research on Educational Effectiveness*, 4, 289–321. <https://doi.org/10.1080/19345747.2010.539297>
- Carreker, S. R., Joshi, M., & Boulware-Gooden, R. (2010). Spelling-related teacher knowledge: The impact of professional development on identifying appropriate instructional activities. *Learning Disability Quarterly*, 33, 148–158. <https://doi.org/10.1177/073194871003300304>
- Ciullo, S., Ely, E., McKenna, J. W., Alves, K. D., & Kennedy, M. J. (2019). Reading instruction for students with learning disabilities in grades 4 and 5: An observation study. *Learning Disability Quarterly*, 42(2), 67–79. <https://doi.org/10.1177/0731948718806654>
- Crim, C., Hawkins, J., Thornton, J., Rosof, H., Copley, J., & Thornton, E. (2008). Early childhood educators' knowledge of early literacy development. *Issues in Teacher Education*, 17(1), 17–30. <https://eric.ed.gov/contentdelivery/servlet/ERICServlet?accno=EJ816593>
- Cunningham, A. E., Perry, K. E., Stanovich, K. E., & Stanovich, P. J. (2004). Disciplinary knowledge of K-3 teachers and their knowledge calibration in the domain of early literacy. *Annals of Dyslexia*, 54, 139–167. <https://doi.org/10.1007/s11881-004-0007-y>
- Denton, C. A., Kethley, C., Nimon, K., Kurz, T. B., Mathes, P. G., Shih, M., & Swanson, E. A. (2010). Effectiveness of a supplemental early reading intervention scaled up in multiple schools. *Exceptional Children*, 76(4), 394–416. <https://doi.org/10.1177/001440291007600402>

- Fletcher, J. M., Lyon, G. R., Fuchs, L. S., & Barnes, M. A. (2019). *Learning disabilities: From identification to intervention* (2nd ed.). Guilford Press.
- Folsom, J. S., Smith, K. G., Burk, K., & Oakley, N. (2017). *Educator outcomes associated with implementation of Mississippi's K-3 early literacy professional development initiative* (REL 2017–270). U.S. Department of Education, Institute for Education Sciences, National Center for Education Evaluation and Regional Assistance, Regional Educational Laboratory Southeast. <https://files.eric.ed.gov/fulltext/ED573545.pdf>
- Foorman, B., Coyne, M., Denton, C., Dimino, J., Hayes, L., Justice, L., Lewis, W., & Wagner, R. (2016). *Foundational skills to support reading for understanding in kindergarten through 3rd grade*. National Center for Education Evaluation and Regional Assistance, Institute for Educational Sciences, U.S. Department of Education. https://ies.ed.gov/ncee/wwc/Docs/PracticeGuide/wwc_foundationalreading_040717.pdf
- Foorman, B. R., & Moats, L. C. (2004). Conditions for sustaining research-based practices in early reading instruction. *Remedial and Special Education, 25*(1), 51–60. <https://doi.org/10.1177/07419325040250010601>
- Foorman, B. R., & Nixon, S. M. (2006). The influence of public policy on reading research and practice. *Topics in Language Disorders, 26*(2), 157–171.
- Fuchs, D., & Fuchs, L. S. (2006). Introduction to response to intervention: What, why, and how valid is it? *Reading Research Quarterly, 41*(1), 93–99. <https://doi.org/10.1598/RRQ.41.1.4>
- Fuchs, L. S., & Vaughn, S. (2012). Responsiveness-to-intervention: A decade later. *Journal of Learning Disabilities, 45*(3), 195–203. <https://doi.org/10.1177/0022219412442150>
- Gersten, R., Haymond, K., Newman-Gonchar, R., Dimino, J., & Jayanthi, M. (2020). Meta-analysis of the impact of reading interventions for students in the primary grades. *Journal of Research of Educational Effectiveness, 13*(2), 401–427. <https://doi.org/10.1080/19345747.2019.1689591>
- Graham, S. (1999). Handwriting and spelling instruction for students with learning disabilities: A review. *Learning Disability Quarterly, 22*(2), 78–98. <https://doi.org/10.2307/1511268>
- Graham, S., & Santangelo, T. (2014). Does spelling instruction make students better spellers, readers, and writers? A meta-analytic review. *Reading and Writing, 27*, 1703–1743. <https://doi.org/10.1007/s11145-014-9517-0>
- Harper, H., & Rennie, J. (2009). ‘I had to go out and get myself a book on grammar’: A study of pre-service teachers’ knowledge about language. *Australian Journal of Language and Literacy, 32*(1), 22–37.
- Hislam, J., & Cajkler, W. (2005). Teacher trainees’ explicit knowledge of grammar and primary curriculum requirements in England. In N. Batels (Ed.), *Applied linguistics and language teacher education* (pp. 295–312). Springer.
- International Dyslexia Association (2018). *Knowledge and practice standards for teachers of reading*. <https://dyslexiaida.org/knowledge-and-practices/>
- International Literacy Association (2010). *Standards for reading professionals – revised 2010*. <https://literacyworldwide.org/get-resources/standards/standards-for-reading-professionals>
- Joshi, R. M., Binks, E., Hougen, M., Dahlgren, M. E., Ocker-Dean, E., & Smith, D. L. (2009). Why elementary teachers might be inadequately prepared to teach reading. *Journal of Learning Disabilities, 42*(5), 392–402. <https://doi.org/10.1177/0022219409338736>
- Joshi, R. M., & Wijekumar, K. (2019). Introduction: Teacher perception, self-efficacy and teacher knowledge relating to literacy. *Annals of Dyslexia, 69*(1), 1–4. <https://doi.org/10.1007/s11881-018-00173-3>
- Kern, D., Bean, R., Dagen, A. S., DeVries, B., Dodge, A., Goatley, V., Ippolito, J., Perkins, H. P., & Walker-Dalhouse, D. (2018). Preparing reading/literacy specialists to meet changes and challenges: International literacy association’s standards 2017. *Literacy Research and Instruction, 57*(3), 209–231. <https://doi.org/10.1080/19388071.2018.1453899>
- Lenth, R. (2020). *emmeans: estimated marginal means, aka least-squares means* (Version 1.5.1). <https://CRAN.R-project.org/package=emmeans>
- Lyon, G. R., & Weiser, B. (2009). Teacher knowledge, instructional expertise, and the development of reading proficiency. *Journal of Learning Disabilities, 42*(5), 475–480. <https://doi.org/10.1177/0022219409338741>
- McCombes-Tolis, J., & Spear-Swerling, L. (2011). The preparation of preservice elementary educators in understanding and applying the terms, concepts, and practices associated with response to intervention in early reading contexts. *Journal of School Leadership, 21*(3), 360–389. <https://doi.org/10.1177/105268461102100303>

- McCutchen, D., Abbott, R. D., Green, L. B., Beretvas, S. N., Cox, S., Potter, N. S., Quiroga, T., & Gray, A. L. (2002). Beginning literacy: Links among teacher knowledge, teacher practice, and student learning. *Journal of Learning Disabilities, 35*(1), 69–84. <https://doi.org/10.1177/002221940203500106>
- McCutchen, D., & Berninger, V. W. (1999). Those who know, teach well: Helping teachers master literacy-related subject-matter knowledge. *Learning Disabilities Research & Practice, 14*(4), 215–226. https://doi.org/10.1207/sldrp1404_3
- McMahan, K. M., Oslund, E. L., & Odegard, T. N. (2019). Characterizing the knowledge of educators receiving training in systematic literacy instruction. *Annals of Dyslexia, 69*, 21–33. <https://doi.org/10.1007/s11881-018-00174-2>
- Miciak, J., & Fletcher, J. M. (2020). The critical role of instructional response for identifying dyslexia and other learning disabilities. *Journal of Learning Disabilities, 53*(5), 343–353. <https://doi.org/10.1177/0022219420906801>
- Moats, L. (1994). The missing foundation in teacher education: Knowledge of the structure of spoken and written language. *Annals of Dyslexia, 44*, 81–102. <https://doi.org/10.1007/BF02648156>
- Moore-Brown, B. J., Montgomery, J. K., Bielinski, J., & Shubin, J. (2005). Responsiveness to intervention: Teaching before testing helps avoid labeling. *Topics in Language Disorders, 25*(2), 148–167.
- Odegard, T. N., Farris, E. A., Middleton, A. E., Oslund, E., & Rimrod-Frierson, S. (2020). Characteristics of students identified with dyslexia within the context of state legislation. *Journal of Learning Disabilities, 53*(5), 366–379. <https://doi.org/10.1177/0022219420914551>
- Ottley, J. R., Piasta, S. B., Mauch, S. A., O'Connell, A., Weber-Mayrer, M., & Justice, L. M. (2015). The nature and extent of change in early childhood educators' language and literacy knowledge and beliefs. *Teaching and Teacher Education, 51*, 47–55. <https://doi.org/10.1016/j.tate.2015.08.005>
- Park, Y., Kiely, M. T., Brownell, M. T., & Benedict, A. (2019). Relationships among special education teachers' knowledge, instructional practice, and students' performance in reading fluency. *Learning Disabilities Research and Practice, 34*(2), 85–96. <https://doi.org/10.1111/lrdp.12193>
- Piasta, S. B., Connor, C. M., Fishman, B. J., & Morrison, F. J. (2009). Teachers' knowledge of literacy concepts, classroom practices, and students' reading growth. *Scientific Studies of Reading, 13*, 224–248. <https://doi.org/10.1080/10888430902851364>
- Podhajski, B., Mather, N., Nathan, J., & Sammons, J. (2009). Professional development in scientifically based reading instruction. *Journal of Learning Disabilities, 42*(5), 403–417. <https://doi.org/10.1177/0022219409338737>
- Pressley, M., Duke, N. K., & Boling, E. C. (2004). The educational science and scientifically based instruction we need: Lessons from reading research and policymaking. *Harvard Educational Review, 74*(1), 30–61. <https://doi.org/10.17763/haer.74.1.5445104446530382>
- R Core Team. (2020). *R: A language and environment for statistical computing* (Version 4.0.3). R Foundation for Statistical Computing. <https://www.R-project.org/>
- Rastle, K. (2019). The place of morphology in learning to read. *Cortex, 116*, 45–54. <https://doi.org/10.1016/j.cortex.2018.02.008>
- Simmons, D. C., Coyne, M. D., Hagan-Burke, S., Kwok, O., Simmons, L., Johnson, C., Zou, Y., Taylor, A. B., Mcalenny, A. L., Ruby, M., & Crevecoeur, Y. C. (2011). Effects of supplemental reading intervention in authentic contexts: A comparison of kindergarteners' response. *Exceptional Children, 77*(2), 207–228. <https://doi.org/10.1177/001440291107700204>
- Spear-Swerling, L. (2009). A literacy tutoring experience for prospective special educators and struggling second graders. *Journal of Learning Disabilities, 42*(5), 431–443. <https://doi.org/10.1177/0022219409338738>
- Spear-Swerling, L., Brucker, P., & Alfano, M. P. (2005). Teachers' literacy-related knowledge and self-perceptions in relation to preparation and experience. *Annals of Dyslexia, 55*(2), 266–296. <https://doi.org/10.1007/s11881-005-0014-7>
- Spear-Swerling, L., & Cheesman, E. (2012). Teachers' knowledge base for implementing response-to-intervention models in reading. *Reading & Writing, 25*, 1691–1723. <https://doi.org/10.1007/s11145-011-9338-3>
- Spear-Swerling, L., & Zibulsky, J. (2014). Making time for literacy: Teacher knowledge and time allocation in instructional planning. *Reading & Writing: An Interdisciplinary Journal, 27*, 1353–1378. <https://doi.org/10.1007/s11145-013-9491-y>
- Stark, H. L., Snow, P., Eadie, P., & Goldfeld, S. (2016). Language and reading instruction in early years' classrooms: The knowledge and self-rated ability of Australian teachers. *Annals of Dyslexia, 66*(1), 28–54. <https://doi.org/10.1007/s11881-015-0112-0>

- Stotsky, S. (2009). Licensure tests for special education teachers: How well they assess knowledge of reading instruction and mathematics. *Journal of Learning Disabilities, 42*(5), 461–474. <https://doi.org/10.1177/0022219409338740>
- Tolman, C. (2017). The relationship between teacher knowledge and effective rti: when we know better, we do better. *Perspectives on language and literacy, 43*(3), 23–27. <http://drcaroltolman.com/wp-content/uploads/2018/06/Summer-2017-3-Tolman-pg1-1.pdf>
- Washburn, E. K., & Mulchay, C. A. (2014). Expanding preservice teachers' knowledge of the English language: Recommendations for teacher educators. *Reading and Writing Quarterly, 30*(4), 328–347. <https://doi.org/10.1080/10573569.2013.819180>
- Weiser, B., & Mathes, P. (2011). Using encoding instruction to improve the reading and spelling performances of elementary students at risk for literacy difficulties: A best-evidence synthesis. *Review of Educational Research, 81*(2), 170. <https://doi.org/10.3102/0034654310396719>
- Wanzek, J., Petscher, Y., Al Otaiba, S., & Donegan, R. E. (2019) Retention of reading intervention effects from fourth to fifth grade for students with reading difficulties. *Reading & Writing Quarterly, 35*(3), 277–288. <https://doi.org/10.1080/10573569.2018.1560379>

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