Intervention Dosage and Interventionist Knowledge in an Upper Elementary Reading Intervention

By

Rachel E. Donegan

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Approved:

Jeanne Wanzek, Ph.D.
Marcia A. Barnes, Ph.D.
Christopher J. Lemons, Ph.D.
Richard Hutton, Ph.D.
Joseph H. Wehby, Ph.D.

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CHAPTER 1

INTRODUCTION

Despite instruction in foundational reading skills including phonemic awareness and word reading starting in the primary grades, many upper elementary students struggle with foundational reading skills, showing below average word reading ability (Leach, Scarborough, Rescorla, 2003; Lipka, Lesaux, & Siegel, 2006). Word reading is an important component of overall reading ability. According to the Simple View of Reading by Gough and Tunmer (1986), overall reading comprehension, the ultimate goal of reading, is the result of a multiplicative relationship between decoding, or word reading, and language comprehension. In other words, even if students show average to above average language comprehension, they are likely to display below average overall reading ability if foundational skills are impaired.

Reading difficulties that emerge or continue in the upper elementary grades may be due to increasing academic demands and the use of more complex text. Both the words appearing in and style of text shifts from what is seen in the primary grades. Words in text increase in difficulty and length and multisyllabic words appear more frequently (Hiebert, 2008). These words require advanced decoding skills unique from those used with single syllable words (Kearns, 2015). Despite this, little time in core reading instruction is spent on phonics or word reading in these grades (Kent, Wanzek, & Al Otaiba, 2017). In addition to increasing word difficulty, a shift in text type poses even more challenges. Informational text, which students have had little exposure to in the primary grades (Duke, 2000), may be used with greater frequency due to more text reading included in content area instruction. Therefore, it may be

particularly critical for interventions for upper elementary students to include instruction in foundational reading skills, such as advanced decoding, and text reading with a variety of different kinds of texts that includes opportunities to practice decoding multisyllabic words to address these increasing challenges.

Interventions that include instruction in phonics and word reading have been effective for increasing older students' reading skills (Flynn, Zheng, & Swanson 2012; Scammacca, Roberts, Vaughn, & Stuebing, 2015; Wanzek, Wexler, Vaughn, & Cuillo, 2010). A recent review of reading intervention research with upper elementary students specifically found that interventions with a strong focus on foundational reading skills, including multisyllabic word reading, were most effective for improving students' foundational reading skills (Donegan & Wanzek, 2020). This is illustrated by two studies included this review. In one study, Vaughn, Roberts, Miciak, Taylor, and Fletcher (2019) examined the effects of a multicomponent reading intervention for fourth- and fifth-grade struggling readers. Students assigned to treatment participated in 30 to 45-min daily lessons which included 20-min of word study instruction, two to five times per week. This instruction included systematic decoding routines with isolated sound patterns and word parts as well as practices to build automaticity. They found effects favoring the treatment group for word reading and fluency (ES = 0.46 to 0.58). In another study, Toste, Capin, Williams, Cho, and Vaughn, (2019) implemented a rigorous, high-quality study examining the effects of a foundational reading intervention focused on multi-syllabic word reading to fourth- and fifth-grade struggling readers. They provided instruction in word parts, syllabication, word reading fluency, and used carefully selected connected text that included targeted multisyllabic words and found significant effects for standardized decoding, word reading, and spelling outcomes (ES = 0.23 to 0.43).

Intervention Intensity

Previous research has provided some evidence the intensity at which an intervention is implemented can impact student outcomes. Fuchs, Fuchs, and Malone (2018) refer to this as intervention dosage, defined as the number of times the student has to respond and receive corrective feedback in an intervention. Intervention dosage has traditionally been defined by measuring the total duration of the intervention and the size of the instructional group in which the intervention is implemented (Fuchs & Fuchs, 2015; Vaughn & Wanzek, 2014). The reasoning being that interventions that include longer or more sessions allow more time for instruction, student practice, and feedback thereby increasing the intensity, or dosage, of the intervention (Vaughn, Wanzek, Murray, & Roberts, 2012). However, work examining the impact of intervention duration or group size on student outcomes has been limited with frequently conflicting results.

There has been limited work examining the effects of reading interventions implemented for different durations. An examination of the effects of an early reading intervention implemented in single and double doses across two separate studies found similar patterns of responding whether students received one or two interventions sessions per day (Wanzek & Vaughn, 2008). In contrast, a study with late elementary struggling readers found some evidence that longer interventions may produce better reading outcomes. Students randomly assigned to two years of intervention demonstrated stronger word reading skills than those randomly assigned to receive intervention for only one year (Miciak et al., 2018).

Studies examining the impact of group size on reading outcome also demonstrate conflicting results. A study with young struggling readers showed students who received reading

intervention individually or in groups of three made more progress than those receiving the same intervention in larger groups of ten (Vaughn et al., 2003). However, similar research completed with older students did not yield the same effects. Vaughn and colleagues (2010) randomly assigned seventh and eighth grade struggling readers to receive an intervention either in smaller groups of three to five students or larger groups of 10 to 15 students. Although they found a pattern of effects sizes favoring the smaller groups for decoding and spelling outcomes, the differences in outcomes between the students in the smaller and larger groups were not statistically significant.

Rather than conclude reading intervention dosage does not consistently impact student reading outcomes, it may be worth considering if the measurement of dosage in these investigations truly captured the amount of reading practice students received. For interventions and intervention components focused on word reading and decoding skills, it may be important to consider the number of words students are reading. This may be a better way to capture variation in dosage when minutes of intervention or group size are fairly similar. Hammerschmidt-Snidarich, Maki, and Adams (2018) argued that number of words read is a better way to measure dosage "because it more precisely quantifies the volume of reading practice in which the student has engaged" (p. 638).

In fact, the number of practice opportunities students have during learning (i.e. opportunities to respond) has been found to be an important predictor of student learning with students who receive more practice demonstrating significant and large learning gains (Szadokierski & Burns, 2008). Previous work has also shown providing students more opportunities to respond and receive feedback during reading instruction is a way to both increase the quality of instruction and is also tied to increases in student reading achievement

(Cuticelli, Collier-Meek, & Coyne, 2015; Fien et al., 2015; MacSuga-Gage & Simonsen, 2015). In one such study, Fien and colleagues (2015) implemented a multi-tiered instruction and intervention model with first-grade struggling readers. Students randomly assigned to treatment received enhanced core (tier 1) reading instruction in addition to intervention. To enhance core reading instruction, core reading teachers of treatment students were trained to make instruction more explicit and increase practice opportunities. Students assigned to treatment showed significant gains from fall to winter on decoding and passage fluency over those assigned to the comparison group (g = 0.42 and 0.34).

Student Characteristics Impacting Intensity

There is evidence that student characteristics, such as current reading ability and behavior, can impact the amount of instruction students receive. It has long been accepted in popular education theory that a reason poor readers tend to remain poor readers is a lack of reading practice. Presented by Stanovich as the Matthew effect in reading, the theory presents the explanation that skilled readers become better readers because their reading ability allows them to read more, while poor readers fail to improve because their reading ability limits the amount of reading they are able to accomplish (1986). In fact, there is a history of research that reading ability is associated with the amount of reading in which students engage demonstrating that less skilled readers read less than higher skilled readers (Allington, 1980; Allington, 1984; Beimiller, 1977-1978).

Student behavior can also impact instruction. A large-scale observation study of classroom instruction and student behavior found students with challenging behaviors were engaged in instruction less of the time and demonstrated higher rates of off task and disruptive

behaviors than their peers without challenging behavior (Hirn & Scott, 2014). Further, there is some evidence that teachers provide a lower rate of instruction and fewer group and individual opportunities to respond when a student with behavior problems is present (Hirn & Scott, 2014; Scott, Alter, & Hirn, 2011)

There is also evidence that student behavior impacts teachers' reading instruction. A small-scale observational study of the reading instruction of six elementary teachers of students with behavioral disabilities indicated teachers placed a greater emphasis on managing student behavior than providing reading instruction (Levy & Vaughn, 2002). Another observational study found high rates of disruptive behavior for students at risk for behavioral disabilities even when provided with small group reading intervention and positive behavioral supports (Wills, Kamps, Abbott, Bannister, & Kaufman, 2010) indicating that even with intervention in place, disruptive behavior may occur and teachers may spend instructional time addressing student behavior rather than providing reading instruction or practice.

Teacher Knowledge

Code-related knowledge. There is existing evidence that teacher knowledge of reading instruction influences student reading outcomes. In fact, professional standards and experts in the field call for teachers of reading to have knowledge of linguistic structures, phonological awareness, and the alphabetic principle (Moats, 1999; International Dyslexia Association, 2018). Knowledge of linguistic structures, phonological awareness, and the alphabetic principle has been referred to as code-related knowledge.

Previous research has shown teachers demonstrate a broad range of code-related knowledge. Early studies investigating the importance of code-related knowledge found low levels of knowledge for the majority of teachers (Moats & Lyon, 1996) even among a sample of experienced and motivated teachers with some graduate level education (Moat, 1994). More recent studies have documented slightly better levels of code-related knowledge among teachers but still found many teachers lacking in adequate knowledge to teach reading, especially for students with reading difficulties and disabilities (Bos, Mather, Dickson, Podhajski, & Chard, 2001; Cunningham, Perry, Stanovich, & Stanovich, 2004; Mather, Bos, & Barbur, 2001; McCutchen, Harry, et al., 2002; Moats & Foorman, 2003; Piasta, Connor, Fishman, & Morrison, 2009; Spear-Swerling, Brucker, & Alfano, 2005; Washburn, Joshi, & Binks-Cantrell, 2011).

Some researchers have investigated how teacher knowledge can be changed to positively impact student outcomes. Several studies have demonstrated code-related knowledge can be improved over short periods of time when teachers were provided with focused, high quality, and intensive professional development (PD; McCutchen, Abbott et al., 2002; McCutchen, Green, Abbott, & Sanders, 2009; Foorman & Moats, 2004; Spear-Swerling & Cheesman, 2012; Podhajski et al., 2009). One study with first grade general education teachers found year-long implementation of a structured reading program that included code-based instruction along with supportive, ongoing PD, resulted in increases in teachers' code-related knowledge when compared to beginning of the year (Carlisle, Cortina, & Katz, 2011).

The previous study demonstrated high quality, ongoing PD plus the extended use of a code-based reading program may have potential for increasing teachers' code-related knowledge. This leaves the question, while high quality and intensive PD alone and high quality, ongoing PD plus implementation of evidence-based reading programs appear to both positively affect teacher

knowledge, does implementation of a code-based reading program alone result in improved knowledge? Cohen, Mather, Schneider, and White (2017) investigated this question with kindergarten through third-grade teachers, approximately half of whom were in districts used a scripted, code-based reading program for core reading instruction. Teachers in this study who used the code-based program had participated in minimal training (one day workshop) in the use of the program and did not have access to ongoing support. Cohen et al. found no differences in code-related knowledge between teachers who did and did not use the program. In other words, use of a program alone did not appear to be enough to significantly affect knowledge.

In addition, a few studies have demonstrated there may be an association between teacher code-related knowledge and the amount of code-related instruction teachers provide. McCutchen, Abbott, et al. (2002) found kindergarten teachers who participated in intensive PD aimed at developing teachers' linguistic knowledge not only showed increases in their knowledge of orthography and phonology but also included more explicit phonological activities in their instruction across the school year. Similarly, another study by McCutchen, Harry et al. (2002) found among kindergarten, first, and second grade teachers, knowledge of phonology showed a significant but weak correlation ($r = .30$) with teachers' use of explicit phonological activities in instruction across the year. However, a later investigation failed to replicate these results with upper elementary teachers (McCutchen et al. 2009).

Several studies have documented the relation between teacher code-related knowledge and student reading outcomes. McCutchen, Harry, et al. (2002) investigated the relation between teachers' code-related knowledge, knowledge of children's literature, classroom practice, and student reading outcomes for K-2 teachers. Although they did not find a significant correlation between teacher knowledge and student reading outcomes for first and second-grade teachers

and students, they did find that kindergarten teachers' phonological knowledge correlated significantly with students' end of year word reading. Moats and Foorman (2003) examined third and fourth grade teachers' code-related knowledge and its relation to student reading outcomes. They found scores on a survey of teacher code-related knowledge were related to end of year reading achievement broadly and specifically predicted student foundational reading skills at one out of two experimental sites.

A few studies have investigated if a similar relation exists between teachers' code-related knowledge and reading achievement for struggling readers. Spear-Swerling and Brucker (2004) examined the impact of professional development in increasing teacher code-related knowledge and the relation of this knowledge to student reading outcomes for second grade struggling readers. They found teachers who participated in the professional development showed increases in knowledge of segmentation, syllable types, and irregular words over teachers who did not participate. In addition, teacher's posttest knowledge of segmentation and irregular words correlated significantly with tutored children's progress in decoding. Only one investigation could be located that assessed the impact of teachers' code-related knowledge to the reading achievement of upper elementary struggling readers. McCutchen et al., (2009) investigated if third, fourth, and fifth grade teachers' linguistic knowledge was associated with the reading achievement of struggling readers. They found that teachers' linguistic knowledge predicted struggling readers' end of year scores on standardized measures of vocabulary, spelling, and decoding with struggling readers of high knowledge teachers showing a 1.3 to 2.2 point advantage over struggling readers of low knowledge teachers.

Piasta et al., (2009) suggest a more complicated relation between teacher knowledge and student outcomes. They examined the relation between teachers' code- related knowledge, the

amount of explicit decoding instruction students received, and student reading outcomes. While they did not find a direct effect for code-related knowledge or amount of decoding instruction on student reading outcomes, they did find student reading outcomes were moderated by the level of teacher code-related knowledge. Specifically, students of more knowledgeable teachers who received more decoding instruction demonstrated stronger word reading gains while students of less knowledgeable teachers who received more decoding instruction demonstrated weaker word reading gains. The results of these studies on code-related knowledge show there may be an important link between teacher code-related knowledge and student reading outcomes. However, a broader view of teacher knowledge may be more appropriate.

Intervention-related knowledge. Shulman (1987) theorized pedagogical content knowledge, the knowledge of both the specific content to be taught as well as knowledge of the pedagogy necessary to convey that knowledge effectively, as especially important for promoting student learning. Phelps and Shilling (2004) applied this framework and hypothesized knowledge needed to teach elementary reading may be comprised of three domains: content knowledge, knowledge of students, and knowledge of teaching. Carlisle, Correnti, Phelps, and Zeng (2009) agree with this broader conceptualization of teacher knowledge needed to teach reading. They examined teacher content knowledge in the five components of reading instruction (phonemic awareness, phonics, fluency, vocabulary, and reading comprehension) in relation to student reading achievement gains and found no differences between first, second, and third-grade students of high, medium, and low knowledge teachers in reading comprehension or word analysis. They hypothesized this was due to the narrow focus of the teacher knowledge assessment on content knowledge and a broader view that includes

knowledge of pedagogy and application of content knowledge to instruction may be more appropriate. Similarly, Fuchs, Fuchs, and Compton (2012) argue the implementation of interventions requires instructional specialists with deep content knowledge, specialized instructional techniques, and knowledge of reading development and difficulties/disabilities.

A pedagogy, or method of instruction, proven as effective for foundational reading core instruction and intervention is explicit, systematic instruction (National Reading Panel, 2000; Foorman et al., 2016; Scammacca et al., 2007). Explicit, systematic instruction is a structured, direct approach to teaching that includes clear explanations and demonstrations of the targets of instruction, scaffolds as necessary, and frequent checks for understanding (Archer & Hughes, 2011). In order to organize instruction in a systematic manner, complex skills are analyzed and broken down into small steps and then carefully sequenced from easier to more difficult (Vaughn et al, 2012).

Brownell et al. (2014) took a broader look at teacher knowledge related to reading instruction and intervention. They examined the learning of five upper elementary special education reading teachers who were participating in professional development (PD) in word study and fluency instruction. The PD was focused on helping teachers increase and integrate knowledge across several areas theorized as important to reading intervention: code-related knowledge, knowledge of instructional strategies, knowledge of student assessment, and knowledge necessary to design data-based instruction. Through knowledge surveys, they found all teachers improved in their knowledge. Analysis of qualitative data using grounded theory revealed the ability to analyze student needs, provide instruction, and adjust the curriculum when needed distinguished teachers who demonstrated great improvements in knowledge from those who demonstrated limited improvements.

Purpose

While some have examined the impact of intervention dosage on reading outcomes, the measurement of dosage across many investigations has been limited to group size and minutes of instruction which may not have precisely captured the amount of reading practice in which students engaged. In addition, while the impact of teacher code-related knowledge on student reading outcomes has been investigated, only one study could be located that investigated this relation for upper elementary struggling readers. A few studies have investigated the impact of teacher knowledge theorized important for reading intervention outside of code-related knowledge, but no studies could be located that linked this knowledge to student reading outcomes. With the findings of Piasta et al. (2009) in mind, I sought to determine if a similar relation between teacher knowledge and student reading outcomes exists for fourth grade struggling readers who are receiving an intensive reading intervention and their interventionists.

Although it's well documented that teacher code-related knowledge can improve after high-quality, intensive, and focused PD, only one study could be located that investigated changes in teachers' code-related knowledge as a result of program use. Cohen et al. (2017) did not find evidence that teacher knowledge changes due to use of a code-based reading program. However, this investigation featured limited initial training and did not include ongoing support for teachers. Therefore, I sought to determine changes would occur if intensive initial training as well as ongoing support were present.

Finally, a few studies have demonstrated for the primary grades, the level of teachers' code-related knowledge can impact the amount of code-based reading instruction they provide; however, an attempt to replicate this finding at the upper elementary level was unsuccessful.

Further, none of these investigations controlled for existing student reading ability or behavior, two variables that have been shown to impact the amount of reading instruction teachers provide.

With all of this in mind, I sought to answer the following research questions:

1. Does intervention dosage predict student word reading gains?
2. Does teacher knowledge predict student word reading gains?
3. Does intervention dosage and teacher knowledge interact to predict student word reading gains?
4. Are there changes in teacher knowledge after implementing an intensive reading intervention?
5. Does teacher knowledge predict the dosage of reading instruction provided during an intensive reading intervention once controlling for students' reading achievement before intervention and teacher reported problem behavior?

Adverse Event

The closure of schools and shelter at home orders due to co-vid 19 left me unable to collect data on student word reading outcomes at the end of the year and, therefore, unable to fully address research questions one, two, and three. This also impacted how the final teacher knowledge assessment was administered. For these questions, I will provide descriptive data on the dosage collected prior to school closure and teacher knowledge data collected in person prior to school closure and via electronic assessment after school closure.

CHAPTER 2

METHODS

The current project is part of a larger project examining the impact of a reading intervention on fourth grade struggling readers.

Participants

To recruit students for the larger project, consented fourth grade students at participating schools were screened using the Test of Word Reading Efficiency, Second Edition (TOWRE-2; Torgesen, Wagner, & Rashotte, 2012). Students whose total word reading scores fell at or below the 30th percentile were randomized to groups where they received a reading intervention, a reading intervention with embedded mindset training, or a comparison group where they received typical school services only. Students assigned to the treatment groups and their research team reading interventionists were participants for this study.

The reading intervention was provided by 11 research team reading interventionists. Ten interventionists were female, nine were Caucasian, one was Hispanic, and one was African American. All reading interventionists had college degrees and seven had undergraduate or graduate degrees in education. On average, interventionists had 7.5 years of prior teaching or tutoring experience. Six interventionists had prior experience using the reading intervention program used in this study. All reading interventionists participated in approximately 40 hours of initial training in the implementation of the intervention and received ongoing coaching support according to fidelity and quality observation scores throughout implementation.

Students in the study attended a total of 11 public elementary schools across 3 school districts in the southern United States. Student demographics are presented in Table 1.

Table 1

Student Demographics

	N	%
Gender		
Female	46	47%
Male	51	53%
Race / Ethnicity		
Caucasian	11	11%
Hispanic	34	35%
African American	28	29%
Asian	1	1%
Multiracial	2	2%
Free/Reduced Lunch	44	45%
Special Education	10	10%

Note. Race/ethnicity is missing for 22% of student participants. Free/reduced lunch data and special education data is missing for 31% of student participants

As a part of the larger project, the reading intervention was implemented in small groups of one to five students. Intervention groups met daily from October till early March for 45 min lessons during the school day. The groups met at various locations throughout the school

according to space availability. Common locations for group meetings included the school library, cafeteria, empty classrooms, and conference rooms.

Intervention

The reading intervention for the treatments was a multicomponent, supplemental reading program that included instruction in phonemic awareness, decoding and word reading, spelling, and comprehension. The first three components were completed using the Lindamood Phoneme Sequencing Program for Reading and Spelling, (LiPS; Lindamood & Lindamood, 2011). LiPS uses oral-motor, visual, and auditory feedback to target phonemic awareness and decoding skills. In the intervention lessons, symbol-sound correspondences were introduced gradually, first in isolation. Then these sounds were practiced during a phonemic manipulation activity. In this activity students orally segmented a word into individual sounds; added, deleted, substituted, or moved sounds to change the word; and represented these changes with manipulatives. Finally, these sounds were practiced during word reading and spelling. During word reading and spelling, strategies were taught for reading and spelling words based on sounds for both single and multisyllable words. Phonics rules and patterns such as final silent e, two vowels go walking, soft c, and soft g were also taught and practiced during this time. Both phonemic manipulation and word reading and spelling instruction were completed using both real and nonsense words. Finally, brief daily sight word practice (> 1 min per student) using individualized lists was completed.

The final component of the lessons was comprised of text reading and comprehension instruction. During this component, students engaged in text reading using leveled texts chosen by the interventionist according to group performance. When the reading abilities of students in

a group was diverse, interventionists were instructed to choose text appropriate for higher performing readers and provide scaffolding to support students with more significant difficulties. Evidence-based practices for comprehension instruction including previewing, summarizing, and questioning were used during this component (National Reading Panel, 2000). Before reading, interventionists led students in previewing text, activating background knowledge, and making a prediction. During and after reading, the interventionist asked literal, inferential, and evaluative questions to monitor student understanding and spark brief discussions around key concepts. For selected texts, instead of asking literal and evaluative questions, interventionists guided students in the use of a strategy to summarize information at several points during reading.

During the first four weeks, instruction focused on sounds and reading single syllable words. During these weeks, 25 min of each lesson was spent on introducing or reviewing sound concepts or phonics rules and phonemic manipulation exercises, and 15 min was spent on reading and spelling with word lists and reading connected texts and comprehension. After the first four weeks of instruction, this gradually shifted to an emphasis on reading words both in lists and connected texts and expanded to include multisyllabic words. During the later lessons, 15 min was spent on introducing or reviewing sound concepts and expectancies and phonemic manipulation exercises and 30 min was spent on reading and spelling with word lists, reading connected texts, and comprehension. Throughout the lessons with the exception of the brief (> 1 min) sight word practice, instruction was standardized across students in each group meaning all students manipulated the same words during phonemic manipulation, read and spelled the same words during reading and spelling, and read the same text during text reading resulting in the same amount of reading practice for all students in each group.

Training

As a part of the larger project, interventionists received approximately 40 hours of training focused provided by senior project staff. Training was focused on intervention implementation and was divided into two parts. Before intervention began, interventionists completed an initial training focused on sound concepts, decoding and spelling single syllable words, beginning comprehension procedures, and positive behavioral supports. During this training, interventionists learned proper sound production and how to label and categorize sounds according to oral motor movements; common phonics rules (for example, silent e) and how to introduce them to students; procedures for phonemic manipulation; strategies for reading and spelling single syllable words; and how to generate inferential, literal, and evaluative questions. This training included approximately 20 hours of direct instruction for interventionists and up to 12 hours of small group and individual practice sessions with hours of practice sessions for each interventionist determined by mastery of instructional routines.

The second part of the training occurred after approximately one month of implementation and focused on reading and spelling with multisyllabic words as well as advanced comprehension procedures such as identifying the main idea of a paragraph and constructing main idea statements to summarize text. Topics covered in the training included constructing a main idea statement, identifying affixes and syllable types, using word parts and syllable division to read words, and procedures for advanced phonemic manipulation activities using multisyllabic words. This second training included approximately 8 hours of direct instruction for interventionists and up to 4 hours of small group and individual practice sessions with hours of practice sessions for each interventionist determined by mastery of instructional routines.

Explanations followed by modeling of instructional techniques and procedures by senior staff occur throughout the direct instruction portion of each training. Interventionists were required to perform instructional routines accurately in mock lessons before implementing them with students. Interventionists also received coaching throughout implementation to continue training and ensure the intervention was implemented with high fidelity and quality. The frequency of coaching each interventionist received was provided according to the amount of previous experience they had using the program (more experienced interventionists received less frequent coaching) and their fidelity and quality scores gathered during fidelity observations (interventionists with high fidelity and quality scores received less coaching).

Measurement

Student measures. As part of the larger project, students completed pretesting on reading measures within three weeks of intervention beginning (see Appendix A). Pretesting was completed by research staff trained to a minimum of 90% reliability on administration and scoring of all assessments. Unfortunately, due to the adverse event, posttesting was unable to be completed as planned.

TOWRE-2 (Torgesen et al., 2012). The TOWRE-2 was used to assess students' word reading fluency. In this timed assessment, students have 45 seconds to read as many words as they can from a list that increases in difficulty. They completed this exercise twice, once with list containing real words and once with a list containing pseudo words. Alternate form

reliability for 4th grade students is reported at .86. Scores obtained on the TOWRE-2 show correlations ranging from .89 to .96 with 15 other measures of word reading.

Social Skills Improvement System Teacher Rating Scale (SSIS; Gresham & Elliott, 2008). The problem behavior scale from the SSIS Teacher Rating Scale was used to measure student problem behavior. Students' classroom teachers completed the rating scale during a 3-week window midway through the academic year. The SSIS is a standardized, norm-referenced assessment of students' behavior, social skills, and academic competency. The problem behavior scale includes items measuring students' externalizing/internalizing behaviors and hyperactivity/attention, based on a 4-point scale of the frequency with which students engage in each behavior (*never, seldom, often,* or *almost always*). The problem behavior scale has test-retest reliability estimates of .75-.85 for children ages 3-18 and internal consistency estimates of .78-.95 for children ages 5-12.

Instructional intensity observations. A count of the number of words segmented and manipulated during phonemic manipulation, read and spelled during word reading and spelling, and read during text reading was used to measure instructional intensity. These data were collected via direct observation as a part of the fidelity measure conducted in the larger project (see Appendix B). These observations occurred once to twice per month for each interventionist with a total of nine observations per interventionist planned during the course of the study. Due to the adverse event, only eight observations were able to be completed for six of the interventionists. Since most interventionists taught more than one instructional group, observations sampled all groups approximately equally (as resources allowed).

All dosage data were collected during fidelity observations conducted as a part of the larger project. As a part of the larger project, observers were required to demonstrate initial reliability using the gold standard method (Gwet, 2001). Each observer completed a fidelity observation using the fidelity measure and it was compared to coding of the same instruction by a senior research team member. Coders were required to demonstrate agreement on six out of seven total component scores when compared to a gold standard (coding by a senior research team member) before beginning observations.

Interventionist knowledge. Interventionist knowledge was assessed at two timepoints**,** at the conclusion of all training in December and three weeks after the unexpected conclusion of intervention in early April when it became clear intervention was unlikely to resume. The first two assessments were completed during in-person small group assessment sessions using paper and pencil assessments. The last assessment was completed electronically via video conference in individual or small group assessment sessions using online quiz software. A senior research team member proctored all assessment sessions, either in person or via video conference.

Code-related knowledge. Interventionists' code-related knowledge was assessed using an adapted version of the Teacher Knowledge Survey: Language and Print (TKS-Adapted; see Appendix C). The original assessment was developed by Piasta and colleagues to assess first grade teachers' knowledge of key concepts of literacy instruction and acquisition as well as their understanding of English phonology, orthography, and morphology (Piasta et al., 2009). It is based on previous surveys of teacher code-related knowledge (Bos et al., 2001; Mather et al.,

2001; Moats, 1994; Moats & Foorman, 2003) and consists of 34 multiple choice items (e.g. how many speech sounds are in the word eight?) and six short answer (e.g. list the 6 syllable types).

I adapted the TKS in two ways. I removed the six short answer items and since these were reported as difficult to score by the authors. I replaced these with multiple choice items tapping knowledge of the same content (syllable types). Also, since the current project focused on older children, I added items focused on the structure and reading of multisyllabic words. In order to develop these items, I first reviewed previous surveys of code-related knowledge, sampling items focused on multisyllabic word reading concepts (Cohen et al., 2017; Moats & Foorman, 2003). I borrowed items directly from these surveys and adapted them to fit the format of the assessment. In order to ensure clarity and accuracy, all additional items were reviewed by two content area experts.

Finally, I conducted cognitive interviews with two respondents with previous experience teaching code-based interventions to ensure the adapted questions were able to be understood and answered by respondents. For the cognitive interviews, I followed a process suggested by Fowler (2002). I conducted the cognitive interviews individually with the two respondents. During the cognitive interviews, respondents were asked to read each item aloud, restate the item in their own words, answer the item, and explain why they chose their answer. I audio-recorded each interview and kept handwritten notes, highlighting any misunderstood items or items answered incorrectly. Results of the cognitive interviews for the TKS indicated items were able to be understood and answered by participants.

Intervention-related knowledge. Knowledge of reading disability and explicit instruction was assessed using the Teacher Intervention Knowledge Assessment (TIK; see Appendix D). A

knowledge assessment of this kind could not be located; therefore this assessment was developed for the purposes of this project. In order to develop it, I reviewed *Explicit Instruction: Effective and Efficient Teaching* by Archer and Hughes (2011), a resource that reviews the basic elements, principles, and research on explicit instruction, to identify principles of explicit instruction theorized to be particularly relevant to reading intervention. I also reviewed a popular synthesis of reading disability research by Vellutino, Fletcher, Snowling, and Scanlon (2004) to identify causes and profiles of reading disabilities as well as implications for practice. Then, I used this information to generate items. Twenty-three items in three categories were included in the assessments: 10 items that focused on knowledge of explicit instruction generally, eight items that focused on knowledge of explicit instruction in reading, and five items focused on knowledge of reading disability. Content-area experts reviewed the assessment to ensure necessary and relevant knowledge was sampled and items were clear and correct. Finally, cognitive interviews were conducted using the same process as described above. Results of the cognitive interviews for the TIK indicated items were able to be understood and answered by participants.

Reliability. I examined internal consistency of both knowledge measures during the study using the Kuder-Richardson Formula 20 (Kuder & Richardson, 1937). Kuder-Richardson is designed to check the internal consistency of measurements with dichotomous choices, such as assessments with correct and incorrect responses. It is calculated using the following formula

$$\rho_{KR20} = \frac{k}{k-1}\left(1 - \frac{\Sigma_{j=1}^{k} p_j q_j}{\sigma^2}\right) \quad (1)$$

Where k is the number of questions, p_j is the number of respondents who answered question j correctly, q_j is the number of people who answered question j incorrectly, and σ^2 represents the variance of the total scores. For the TKS, reliability calculated for the current sample was .91 at the post-training assessment and .85 at the end of intervention assessment.

For the TIK, reliability was calculated separately for each section of the assessment. This approach was taken because each section of the assessment (general knowledge of explicit instruction, knowledge of explicit reading instruction, knowledge of reading disability) focused on different areas of knowledge theorized to be important for reading intervention implementation. Due to low reliability of sections on general knowledge of explicit instruction ($\alpha = .10$) and knowledge of reading disability ($\alpha = .17$), only the section on knowledge of explicit reading instruction was used to answer research question four and five. Reliability for the TIK explicit reading instruction section was .63 at the post training assessment and .58 at the end of intervention assessment.

Analysis

First, I examined the data descriptively. For the dosage variables, I combined the word counts for phonemic manipulation and word reading and spelling instruction into one variable which I will refer to as word-level dosage. I also calculated the number of words read during text reading which I will refer to as text-level dosage. I calculated means and standard deviations for word-level and text-level dosage across all observations and for each interventionist. I also examined distribution and normality using visual displays and significance tests. I followed similar procedures to descriptively examine interventionists' scores on December and April TIK and TKS-Adapted.

To address the first three research questions concerning the effects of teacher knowledge and instructional intensity on student reading outcomes, I planned to use multilevel modeling. Multilevel modeling is appropriate for data with a nested structure, such as students nested in classrooms or with teachers (Snijders & Bosker, 2012). First, I planned to use a series of unconditional models to estimate the cluster level variance and determine the appropriate nesting (for example, students nested in intervention groups or students nested in interventionist). Then I planned to use a series of multilevel level models with student pretest score as the level one variable; word counts during phonemic manipulation, reading and spelling, and text reading as level two variables; and teacher code-related and intervention-related knowledge as level two variables. In order to answer my third research question, I planned to add interaction terms to these models, retaining those with significant effects. Due to the adverse event I was unable to complete the planned analysis to answer research questions one, two, and three.

To answer research four, "Are there changes in teacher knowledge after implementing an intensive reading intervention?" I used matched-samples t-tests to compare the changes in interventionists' scores on the TKS-Adapted and TIK explicit reading instruction items at the December and April timepoints. Matched-sample t-tests are appropriate for comparing data collected from the same participants at two different timepoints to test if there is a significant change in participant scores across time (Howell, 2011).

To answer research question five, "Does teacher knowledge predict the dosage of reading instruction provided during an intensive reading intervention?" I used multilevel modeling with observations nested in interventionist. I used interventionist scores on the TKS-Adapted for both models because the reliability for the TIK was poor. Therefore this question focused specifically on if interventionists' code-related knowledge predicted the word- or text-level dosage they

provided. Restricted maximum likelihood (REML) was used for estimation of all multilevel models. REML is the recommended method of estimation when the number of clusters is small to avoid biased variance components estimates (McNeish & Stapleton, 2016). First, I used unconditional models to estimate the cluster-level variance for dosage. Then I used two multilevel models, one predicting word-level dosage and one predicting text-level dosage with grand-mean centered interventionist knowledge scores entered as a level 2 variable. To control for students' reading levels and behavior, total word scores on the TOWRE-2 and problem behavior ratings on the SSIS Teacher rating scale were aggregated to the interventionist level by calculating an average score for each interventionist and entering these as level 2 covariates in the multilevel models described above. Standard scores were used in all analyses. The models were presented as

$$y_{ij} = \gamma_{00} + \gamma_{01} CRKnowledge_j + \gamma_{02} AvgRdg_j + \gamma_{03} AvgProbBeh_j + u_{0j} + e_{ij} \quad (2)$$

where the subscript i refers to the observation (level 1), the subscript j refers to the reading interventionist in which the observation is nested (level 2), y_{ij} is dosage, γ_{00} is the grand mean dosage across reading interventionists, $\gamma_{01} CRKnowledge_j$ represents the effect of interventionist code-related knowledge, $\gamma_{02} AvgRdg_j$ represents the effect of the average reading performance of each interventionists' students as measured by the TOWRE-2 total word score, $\gamma_{03} AvgProbBeh_j$ represents the effect of the average problem behavior of each interventionists' students as measured by the SSIS Teaching Rating Scale problem behavior score, u_{0j} is the deviation of each level 2 mean from the grand mean, and e_{ij} is the level 1 prediction error.

CHAPTER 3

RESULTS

Due to the adverse event, I was unable to complete the full analysis to answer research questions one, two and three that focused on the impact of teacher knowledge and dosage on student reading outcomes. Therefore, my results for these questions are limited to the descriptive analyses for the dosage data and the results of the teacher knowledge assessments described in the previous section. Across all observations, word-level dosage averaged 19.82 words (standard deviation [*SD*] = 7.05) per instructional session. Text-level dosage averaged 213.62 words (*SD* = 143.05) per instructional session. Means per interventionists for word-level and text-level dosage are presented in Figures 1 and 2.

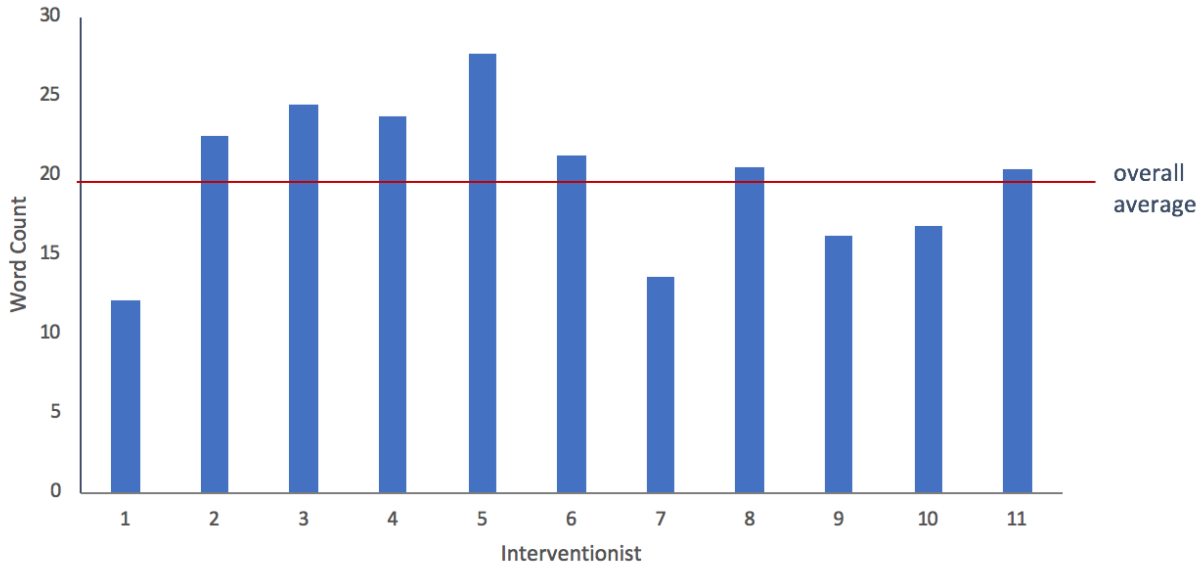


Figure 1. Average word-level dosage across interventionists

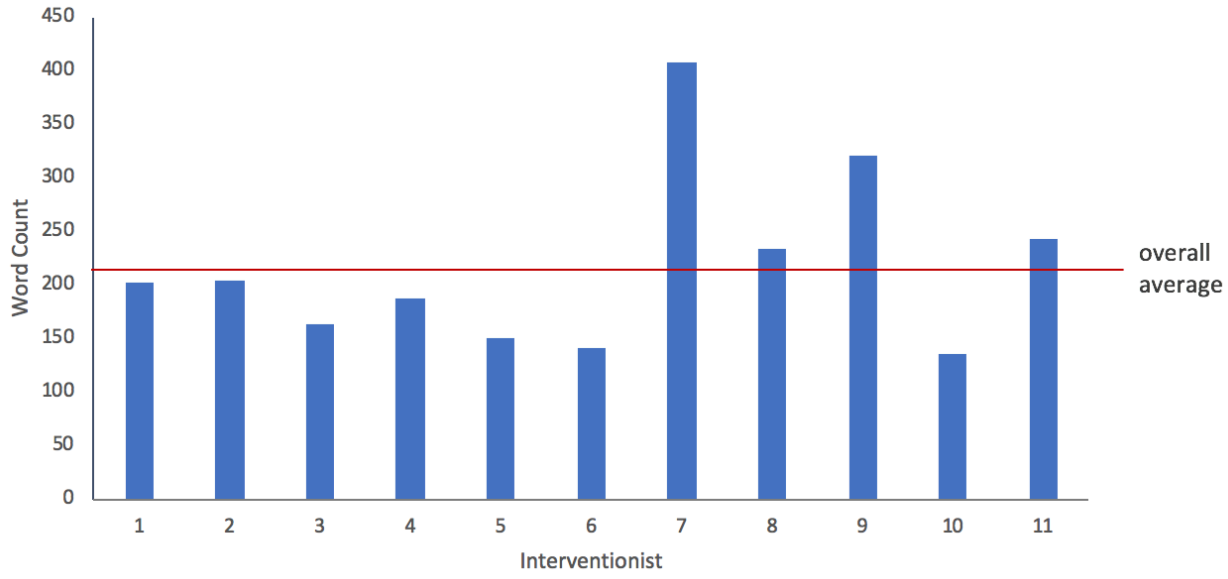


Figure 2. Average text-level dosage across interventionists

I examined the distribution of the dosage data using visual displays and conducting significance tests. Shapiro-Wilk indicated word-level dosage was normally distributed (W (81) = 0.97, p = .10) which was confirmed with visual displays. Shapiro-Wilk indicated a significant departure from the normal distribution for text-level dosage (W (81) = 0.90, p < .001). According to further analysis through visual displays, the distribution was positively skewed with five observations at the top of the distribution. Standardized residuals from these observations fell between -3.3 and 3.3, the threshold Tabachnick and Fidell (2013) use to define outliers. Therefore, these observations were retained.

I followed similar procedures for examining the total scores on the TKS-Adapted and the score for the explicit reading instruction items on the TIK. Descriptive data are presented in Table 2.

Table 2

Interventionist Knowledge Assessment Scores After Training and After Intervention

	n	M	SD
December			
TKS-Adapted	11	32.55	7.27
TIK Explicit Reading Instruction	11	6.73	1.35
April			
TKS-Adapted	11	34.09	5.72
TIK Explicit Reading Instruction	11	6.18	1.40

Note. TKS-Adapted scores are out of 44 total items. TIK scores are out of 8 total items

Knowledge survey scores on the TIK indicated high levels of knowledge in explicit reading instruction with nine interventionists answering 75% or more questions correctly in December and seven interventionists answering 75% or more questions correctly in April. Scores on the TKS-Adapted obtained after all training was completed in December indicated most respondents showed high levels of code-related knowledge after training. Seven out of 11 interventionists answered 75% or more of the questions correctly on the December assessment. Knowledge was also high after intervention with eight out of 11 interventionists answering 75% or more of the questions correctly. Shapiro-Wilk indicated TKS-Adapted scores were normally distributed at both December (W (11) = 0.93, p = .38) and April assessments (W (11) = 0.94, p = .53) which was confirmed with visual displays. Analysis of visual displays for scores on the TIK indicated a negative skew in the distribution of December scores although this was not

significant (W (11) = 0.87, p = .07). Shapiro-Wilk indicated TIK April scores were normally distributed (W (11) = 0.90, p = .18).

After descriptively examining data, I conducted planned analyses to answer research question four. For the TIK explicit reading instruction, there was a mean decrease in scores from December to April of .55 items, however, this change was not significant (t (10) = -1.49, p = .17). For the TKS-Adapted, there was a mean increase in scores of 1.54 items from December to April, however, this change was not significant (t (10) = 1.85, p = .09).

In order to further explore the change in interventionists' code-related knowledge across time, I considered interventionists' level of code-related knowledge immediately after training. To do this, I divided the interventionists into two groups according to their scores on the knowledge assessment given at this timepoint. Those who answered 75% or more of questions correct were considered to possess sufficient code-related knowledge and those who answered less than 75% of questions correct were considered to possess insufficient code-related knowledge. Next, I calculated the average change score (December to April) for each group along with graphing each interventionists' score at both timepoints. I found interventionists with sufficient knowledge after training increased their scores by 0.14 items. The change in scores for each interventionist demonstrating sufficient knowledge is seen in Figure 3.

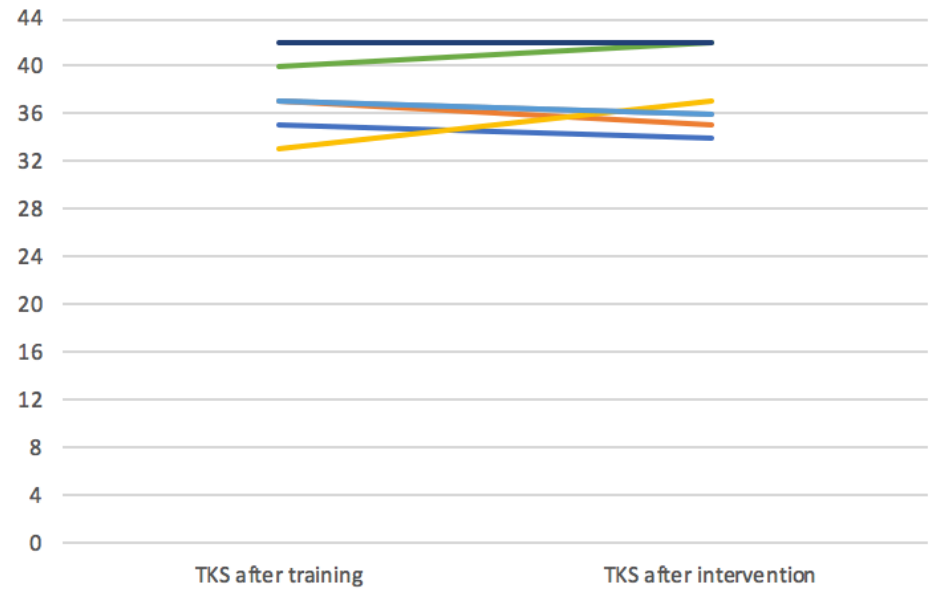


Figure 3. Changes in code-related knowledge for interventionists with sufficient knowledge

In contrast, interventionists with insufficient knowledge after training increased their scores by 4 items. The change in scores for each interventionist demonstrating insufficient knowledge is seen in Figure 4.

Figure 4. Changes in code-related knowledge for interventionists with insufficient knowledge

To answer research question five, if interventionist knowledge predicted dosage once controlling for student word reading ability and problem behavior reported by classroom teachers, I first descriptively examined the word and text level dosage data for each interventionist (see descriptions earlier in this section and Figures 1 and 2). Next, I descriptively examined the covariates which included TOWRE-2 total word score and the Problem Behavior score from the SSIS. The averages of aggregate scores by interventionist are presented in Table 3.

Table 3

Average of the Averages for Student Reading Achievement and Problem Behavior

	n	M	SD
TOWRE-2 Total Word Score	11	79.85	4.52
SSIS Problem Behavior	11	102.13	7.45

On average, interventionists' students demonstrated below average word reading fluency as measured by the TOWRE-2 and average problem behavior as measured by the SSIS. Shapiro-Wilk indicated aggregated TOWRE-2 total word scores were normally distributed (W (11) = 0.92, p = .30). Shapiro-Wilk also indicated aggregated SSIS problem behavior scores were normally distributed (W (11) = .98, p = .96).

Correlations of word- and text-level dosage with predictors variables aggregated to the interventionist level are presented in Table 4.

Table 4

Intercorrelations of Dosage, Knowledge and Aggregated Student Covariates

	Word-Level Dosage	Text-Level Dosage	TKS Adapted	TOWRE-2	SSIS
Word-Level Dosage	1				
Text-Level Dosage	-.54	1			
TKS Adapted	.28	-.27	1		
TOWRE-2	.19	.27	.30	1	
SSIS	-.43	.22	-.23	-.19	1

Note. All correlations were nonsignificant

Correlations between word-level dosage and interventionists' scores on the TKS were weak and positive while correlations between text-level dosage and interventionists' scores on the TKS were weak and negative. Correlations between word-level dosage as well as text-level dosage and student scores on the TOWRE-2 were weak and positive. Correlations between word-level dosage and students' scores on the SSIS were moderate and negative. Correlations between text-level dosage and scores on the SSIS were weak and positive. None of these correlations were significant.

In order to estimate cluster level variance, I entered the dosage variables into the model with each observation nested in interventionist. The unconditional model found substantial variance at the interventionist level for both word- and text-level dosage (word-level dosage interclass correlation [ICC] = 0.39; text-level dosage ICC = 0.22).

Next, I added my predictor, interventionist's score on the TKS administered immediately after training, and covariates, aggregated student scores for each interventionist's students on the TOWRE-2 and SSIS. Results of the multilevel models showed no significant associations between word-level or text-level dosage and interventionist's score on the TKS after controlling for word reading and problem behavior levels of the interventionist's students. Fixed effects for both models are presented in Table 5. Random effects for both models are presented in Table 6.

Table 5

Fixed Effects of Multilevel Models Predicting Dosage

	Estimate	*SE*	*p*
Word-Level Dosage			
Intercept	38.38	40.47	.37
TKS Adapted	0.12	0.24	.64
TOWRE-2 Total Reading	0.08	0.38	.84
SSIS Problem Behavior	-0.25	0.22	.31
Text-Level Dosage			
Intercept	-627.59	681.29	.39
TKS Adapted	-3.77	4.04	.38
TOWRE-2 Total Reading	7.35	6.37	.29
SSIS Problem Behavior	2.51	3.81	.53

Table 6

Random Effects of Multilevel Models Predicting Dosage

		Percent of variation	*Estimate*	*SE*	*p*
Word-level Dosage	Level 1	57.38%	30.66	4.87	< .001
	Level 2	42.62%	22.78	9.04	.11
Text-level Dosage	Level 1	76.33%	16590.97	2805.39	< .001
	Level 2	23.67%	5145.39	3972.90	.20

CHAPTER 4

DISCUSSION

During this study, I sought to answer research questions concerning the effects of intervention dosage and interventionist knowledge on student reading outcomes, the growth of teacher knowledge during the course of a reading intervention, and the effects of teacher knowledge on intervention dosage. Due to the adverse event, I was unable to answer the questions concerning the effects of dosage and knowledge on student reading outcomes. Therefore, my discussion of findings will focus on the change in interventionist knowledge during the course of the reading intervention, the descriptive findings for dosage, and the effects of interventionist knowledge on intervention dosage.

I aimed to measure knowledge critical for reading interventionists. I theorized one aspect of this knowledge, referred to as intervention-related knowledge, was made up of (a) knowledge of explicit instruction generally, an effective instructional technique for struggling learners; (b) explicit reading instruction; and (c) knowledge of reading disability. Therefore, I constructed a measure tapping knowledge in all areas. However, through testing the reliability of this measure, I found the participants in my study who were all trained reading interventionists, had knowledge in some but not all of these domains, which contributed to low reliability when my measure was considered wholly. Further, even once I considered the domains separately, the reliability of each of the domains still fell below acceptable levels ($\alpha \geq .70$; Cortina, 1993)

The most reliable domain of my intervention-related knowledge measure (though reliability still fell below acceptable levels) was knowledge of explicit reading instruction.

Phelps and Schilling (2004) investigated the content knowledge elementary teachers need to teach reading and found content knowledge and knowledge of teaching and content formed two clearly defined factors. Similar to knowledge of explicit reading instruction identified for my study, knowledge teaching and content as defined by Phelps and Schilling requires both an understanding of content and knowledge of effective teaching techniques.

I did not find evidence interventionists' knowledge of explicit reading instruction changed while implementing the intensive reading intervention. This may be explained through the intervention materials and training provided to support implementation. The intervention materials included an outline of the daily lesson, a sequence and suggested pacing for skill introduction across the intervention, and sample dialogue that included teacher and student talk for introduction of new skills. During the intervention training, each component of instruction was modeled by trainers and practiced by interventionists. Explicit instruction techniques such as scaffolding to support student errors and methods to ensure adequate practice and engagement were embedded within the modeled and practiced instruction in the training. Training in these techniques were included as they support high quality instruction and therefore high quality implementation of the intervention program. The training or intervention materials did not identify the explicit instruction techniques as such nor did it focus on why these techniques are necessary for high quality instruction. The intervention materials also did not include information on how to adjust the saliency and delivery of these techniques to increase the intensity of instruction, an area of explicit instruction knowledge tested in questions 14 and 15 on the TIK.

I also sought to answer a question that considered changes in interventionists' code-related knowledge. Specifically, after interventionists participated in intensive program

implementation training, did their code-related knowledge change as they used a validated reading intervention program focused on phonemic awareness, decoding, spelling, and text reading? Corresponding with previous findings (Cohen et al., 2017), interventionists overall did not demonstrate a significant increase in code-related knowledge during the course of the intervention. This may be due in part to the high level of knowledge interventionists in this study demonstrated at both time points, answering on average 74% of questions correctly on the knowledge assessment administered immediately after the training and 77.5% of questions correctly on the knowledge assessment administered immediately after the completion of the intervention. This is a higher level of knowledge than recorded during previous studies (Bos et al., 2001; Cohen et al., 2017; McCutchen et al., 2009).

Although, I did not find changes in interventionists' code-related knowledge broadly, I did find preliminary evidence there may have been different changes in code-related knowledge between interventionists with sufficient knowledge and interventionists with insufficient knowledge. Through a descriptive analysis that considered interventionists' level of code-related knowledge immediately after training, I found that while interventionists who demonstrated sufficient code-related knowledge after training demonstrated negligible increases in knowledge, interventionists with lower levels of code-related knowledge demonstrated more substantial increases, answering on average 4 more questions correctly. In other words, during the course of the intervention, interventionists with higher levels of code-related knowledge appeared to have maintained their knowledge while interventionists with lower levels of code-related knowledge appeared to have grown their knowledge.

Others have noted the importance of a high-quality program for supporting teachers' delivery of reading interventions. One case study focused on elementary special education

teachers found one of their teacher participants with limited experience, education, and low levels of code-related knowledge and benefitted from a structured code-based curriculum. Specifically, the curriculum allowed him to provide adequate reading instruction for his students that he otherwise would have been unable to deliver (Dingle, Brownell, Leko, Boardman & Haager, 2011). However, the researchers also noted that a lack of code-related knowledge also left this participant unable to adjust instruction appropriately, answer student questions, or veer from the scripted daily lesson plans. The authors concluded interventionists who possess limited code-related knowledge may benefit from a structured code-based curriculum, however, use of such a program would not compensate for a lack of knowledge. Overall, the relation of code-based program use and code-based knowledge is an area that warrants further investigation.

I did not find interventionists' knowledge predicted the dosage of word reading and spelling or text reading instruction interventionists provided once controlling for their students' word reading and behavior. In fact, the correlations between code-related knowledge and dosage were small and insignificant. This is a small sample which can make the correlational data less reliable. Another possible explanation for the lack of a relation between these two variables is the grade level of student participants in the study. Previous investigations that found evidence of a relation between teachers' code-related knowledge and amount of reading instruction provided were done with students in the primary grades (McCutchen, Abbott et al., 2002; McCutchen, Harry, et al., 2002). In another past investigation that failed to find a relation (McCutchen et al., 2009) and the current investigation, student participants were in the upper elementary grades.

The lack of variety in reading intervention program and other implementation variables also may explain the null effects. All interventionists in the current investigation used the same

intervention program and implemented the program with adequate to high levels of fidelity. Although there was still variation in dosage, it's possible without these programmatic features of the larger study the variation between interventionists would have been larger.

Implications and Directions for Future Research

In terms of dosage, perhaps one of the more interesting findings is the varying dosage from interventionists in this study even though interventionists used the same intervention with similar structures (group size and session duration) and implemented the program, with adequate to high levels of fidelity. Other researchers have also shown students participating in the same reading interventions using the same or similar structures (similar group size and similar session duration) can experience different dosages demonstrating group size and minutes of intervention or number of sessions may be imprecise measures of dosage (Hammerschmidt-Snidarich et al., 2018; Snidarich, 2015). Further, dosage as defined by number of words read may predict reading outcomes better than dosage defined as minutes of intervention or number of intervention sessions (Snidarich, 2015).

This has important implications for reading interventions when considering intensity, especially for students with severe reading difficulties and disabilities. When considering if an intervention is intensive enough (or has been intensified enough), practitioners may want to consider number of words read alongside minutes of intervention or sessions attended when evaluating dosage. Overall, more investigations into what causes differences in dosage are needed.

Previous investigations have demonstrated the effectiveness of PD for increasing teacher code-related knowledge. Through exploratory and descriptive analysis, I found preliminary

evidence that interventionists with lower levels of code-related knowledge may continue to develop knowledge in this area weeks after receiving PD. It's unclear if this observed change in knowledge was due to use of the reading intervention program, continued support through coaching focused on intervention fidelity and delivery, a combination of these two factors, or simply the passage of time. Due to the small number of interventionists (n = 11) overall and even smaller number of interventionists in both of these subgroups (seven with sufficient code-related knowledge and four with insufficient code-related knowledge), it's difficult to make broad conclusions. However, this finding is important to note as it may indicate that even when teachers fail to develop adequate knowledge immediately after PD, it's possible for this knowledge to develop given longer period of time. This may be an important finding also in light of research on effective professional development which has demonstrated that PD that includes follow-up may be more effective than one-time trainings (Brock et al., 2017). Since this finding was based on an exploratory and descriptive analysis, more research is needed to determine if differential changes in knowledge are indeed occurring.

Limitations

This study had several limitations. First, I encountered difficulties constructing knowledge survey to measure intervention related knowledge. In the end, I only used questions from TIK focused on knowledge of explicit reading instruction. Still, the reliability of this measure was low. Second, most interventionists (n = 10) had multiple intervention groups, however, the observation schedule along with multilevel models used did not allow for estimations of dosage for each intervention group. Results may be different if each group was considered individually. Third, the measure of student word reading ability was administered

before intervention began and considered word reading ability at a single point in time. In other words, word reading ability was considered a static variable in this investigation. However, since student participants continued to receive their regular reading instruction from their classroom teacher and intervention that included a substantial focus on word reading and decoding, it's likely students' reading ability changed as the intervention progressed. Therefore, the results of this investigation may have been different if the measurement of this covariate could capture the likely dynamic nature of this variable. Finally, a small sample size, both in observations and in the number of interventionists, may have contributed to imprecise estimates reflected in the large standard errors for parameter estimates in both multilevel models.

Conclusion

Similar to many studies, the findings (and lack thereof) in this investigation resulted in more questions than answers. The adverse event left me unable to answer questions regarding the relation of dosage, interventionist knowledge, and student reading outcomes. Overall, more investigations in this area are needed. Related to dosage, the descriptive results of this study demonstrating varying dosage for both word-level and text-level practice within one intervention point to a need to examine dosage across interventionists at a close level, even within a single intervention. In terms of interventionists' knowledge, there was some preliminary evidence interventionists with lower levels of code-related knowledge continue to develop this knowledge as they use a code-based intervention. However, more research is needed to confirm this finding and extend it beyond research team interventionists to teachers in the field. Previous research points to ongoing support as a key piece of effective PD. It's possible that the ongoing support provided to the interventionists contributed to the change in knowledge, however, a more

rigorous investigation is needed before this conclusion can be reached. Finally, the relation of dosage and knowledge is still unclear. Although I did not find effects for interventionist knowledge on dosage in this investigation, my findings were limited due to design and a small number of interventionists.

Detailed examinations of these variables, which may affect outcomes for struggling readers participating in reading interventions, are sorely needed. A continuing trend of diminishing effects of upper elementary reading interventions (Donegan & Wanzek, 2020) along with stagnating reading achievement overall and for students with disabilities at this level (National Center for Education Statistics, 2017) both emphasize this critical need.

REFERENCES

Allington, R. (1980). Poor readers don't get to read much in reading groups. *Language Arts, 57*, 873–875.

Allington, R. (1984). Content coverage and contextual reading in reading groups. *Journal of Reading Behavior, 16*, 85–96. https://doi.org/10.1080/10862968409547506

Archer, A. L., & Hughes, C. A. (2011). *Explicit Instruction: Effective and Efficient Teaching.* New York, NY: Guilford Press.

Biemiller, A. (1977). Relationships between oral reading rates for letters, words, and simple text in the development of reading achievement. *Reading Research Quarterly, 13*, 223–253. https://doi.org/10.2307/747307

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*(1), 97–120. https://doi.org/10.1007/s11881-001-0007-0

Brock, M., Cannella-Malone, H., Seaman, R., Andzik, N., Schaefer, J., Page, E., … Dueker, S. (2017). Review of findings across practitioner training studies in special education: A comprehensive review and meta-analysis. *Exceptional Children, 84*, 7–26. https://doi.org/10.1177/0014402917698008

Brownell, M., Lauterbach, A., Dingle, M., Boardman, A., Urbach, J., Leko, M., … Park, Y. (2014). Individual and contextual factors influencing special education teacher learning in literacy learning cohorts. *Learning Disability Quarterly*, *37*(1), 31–44. https://doi.org/10.1177/0731948713487179

Carlisle, J., Cortina, K., & Katz, L. (2011). First-grade teachers' response to three models of professional development in reading. *Reading & Writing Quarterly, 27*, 212–238. https://doi.org/10.1080/10573569.2011.560482

Carlisle, J., Correnti, R., Phelps, G., & Zeng, J. (2009). Exploration of the contribution of teachers' knowledge about reading to their students' improvement in reading. *Reading and Writing*, *22*, 457–486. https://doi.org/10.1007/s11145-009-9165-y

Cohen, R. A., Mather, N., Schneider, D. A., & White, J. M. (2017). A comparison of schools: Teacher knowledge of explicit code-based reading instruction. *Reading and Writing, 30,* 653-690. https://doi.org/10.1007/s11145-016-9694-0

Cortina, J. (1993). What is coefficient alpha? An examination of theory and applications. *Journal of Applied Psychology, 78*, 98–104. https://doi.org/10.1037/0021-9010.78.1.98

Cunningham, A., Perry, K., Stanovich, K., & Stanovich, P. (2004). Disciplinary knowledge of K-3 teachers and their knowledge calibration in the domain of early literacy. *Annals of Dyslexia, 54*(1), 139–167. https://doi.org/10.1007/s11881-004-0007-y

Cuticelli, M., Collier-Meek, M., & Coyne, M. (2016). Increasing the quality of tier 1 reading instruction: Using performance feedback to increase opportunities to respond during implementation of a core reading program. *Psychology in the Schools*, *53*(1), 89–105. https://doi.org/10.1002/pits.21884

Dingle, M., Brownell, M., Leko, M., Boardman, A., & Haager, D. (2011). Developing effective special education reading teachers: The influence of professional development, context, and individual qualities. *Learning Disability Quarterly, 34*, 87–103. https://doi.org/10.1177/073194871103400106

Donegan, R. E., & Wanzek, J. (2020). *Effects of reading interventions for upper elementary struggling readers: A look at recent research.* Manuscript submitted for publication.

Duke, N. K. (2000). 3.6 minutes per day: The scarcity of informational texts in first grade. *Reading Research Quarterly, 35,* 202–224. http://dx.doi.org/10.1598/RRQ.35.2.1

Fien, H., Smith, J. L. M., Smolkowki, K., Baker, S. K., Nelson, N. J., & Chaparro, E. (2015). An examination of the efficacy of a multi-tiered intervention on early reading outcomes for first grade students at risk for reading difficulties. *Journal of Learning Disabilities, 48*(6), 602-621. https://doi.org/ 10.1177/0022219414521664

Flynn, L., Zheng, X., & Swanson, H. (2012). Instructing struggling older readers: A selective meta-analysis of intervention research. *Learning Disabilities Research & Practice 27*(1), 21–32. https://doi.org/10.1111/j.1540-5826.2011.00347.x

Foorman, B., Beyler, N., Borradaile, K., Coyne, M., Denton, C. A., Dimino, J., … Wissel, S. (2016). *Foundational skills to support reading for understanding in kindergarten through 3rd grade* (NCEE 2016-4008). Washington, DC: National Center Department of Education. Retrieved from the NCEE website: http://whatworks.ed.gov.

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

Fowler, F. J. (2002). *Survey research methods, third edition.* Thousand Oaks, CA: Sage Publications.

Fuchs, D., & Fuchs, L. S. (2015). Rethinking service delivery for students with significant learning problems: Developing and implementing intensive instruction. *Remedial and Special Education*, *36*, 105–111. https://doi.org/10.1177/0741932514558337

Fuchs, D., Fuchs, L. S., & Compton, D. L. (2012). Smart RTI: A next-generation approach to multilevel prevention. *Exceptional Children*, *78*, 263–279. https://doi.org/10.1177/001440291207800301

Fuchs, L. S., Fuchs, D., & Malone, A. S. (2018). The taxonomy of intervention intensity. *TEACHING Exceptional Children*, *50*, 194–202. https://doi.org/ 10.1177/0040059918758166

Gough, P., & Tunmer, W. (1986). Decoding, reading, and reading disability. *Remedial and Special Education, 7,* 6-10.

Gresham, F. M., & Elliott S. N. (2008) *Social Skills Improvement System Rating Scales.* Minneapolis, MN: NCS Pearson.

Gwet, K. (2001). *Handbook of inter-rater reliability: How to estimate the level of agreement between two or multiple raters.* Gaithersburg, MD: STATAXIS Publishing Company.

Hammerschmidt-Snidarich, S., Maki, K., & Adams, S. (2019). Evaluating the effects of repeated reading and continuous reading using a standardized dosage of words read. *Psychology in the Schools, 56*, 635–651. https://doi.org/10.1002/pits.22241

Hiebert, E.H. (2008). The (mis)match between texts and students who depend on schools to become literate. In E.H. Hiebert & M. Sailors (Eds.), *Finding the right texts: What works for beginning and struggling readers* (pp. 1-20). New York, NY: Guilford.

Hirn, R., & Scott, T. (2014). Descriptive analysis of teacher instructional practices and student engagement among adolescents with and without challenging behavior. *Education and Treatment of Children, 37*, 589–610. https://doi.org/10.1353/etc.2014.0037

Howell, D. C. (2011). Hypothesis tests applied to means. In *Statistical methods for psychology (*pp. 177-228). Belmont, CA: Wadsworth.

International Dyslexia Association (2018). *Knowledge and Practice Standards for Teachers of Reading.* Retrieved from https://dyslexiaida.org/knowledge-and-practices/

Kearns, D. (2015). How elementary-age children read polysyllabic polymorphemic words. *Journal of Educational Psychology*, *107*(2), 364–390. https://doi.org/10.1037/a0037518

Kent, S., Wanzek, J., & Al Otaiba, S. (2017). Reading instruction for fourth-grade struggling readers and the relation to student outcomes. *Reading & Writing Quarterly*, *33*(5), 395–411. https://doi.org/10.1080/10573569.2016.1216342

Kuder, G. F, & Richardson, M. W. (1937). The theory of the estimation of test reliability. *Psychometrika*, *2*(3), 151-160. https://doi.org/10.1007/BF02288391

Leach, J. M., Scarborough, H., & Rescorla, L. (2003). Late-emerging reading disabilities. *Journal of Educational Psychology*, *95*(2), 211–224. https://doi.org/10.1037/0022-0663.95.2.211

Levy, S., & Vaughn, S. (2002). An observational study of teachers' reading instruction of students with emotional or behavioral disorders. *Behavioral Disorders, 27*, 215–235. https://doi.org/10.1177/019874290202700303

Lindamood, P. C., & Lindamood, P. D. (2011). *The Lindamood Phoneme Sequencing Program for Reading, Spelling, and Speech, Fourth Edition*. Austin, TX: Pro-Ed.

Lipka, O., Lesaux, N., & Siegel, L. (2006). Retrospective analyses of the reading development of Grade 4 students with reading disabilities: Risk status and profiles over 5 years. *Journal of Learning Disabilities*, *39*(4), 364–378. https://doi.org/10.1177/00222194060390040901

MacSuga-Gage, A. S., & Simonsen, B. (2015). Examining the effects of teacher-directed opportunities to respond on student outcomes: A systematic review of the literature. *Education and Treatment of Children, 38*(2), 211-239.

Mather, N., Bos, C., & Babur, N. (2001). Perceptions and knowledge of preservice and inservice teachers about early literacy instruction. *Journal of Learning Disabilities,* 34(5), 472–482. https://doi.org/10.1177/002221940103400508

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

McCutchen, D., Green, L., Abbott, R., & Sanders, E. (2009). Further evidence for teacher knowledge: supporting struggling readers in grades three through five. *Reading and Writing, 22*, 401–423. https://doi.org/10.1007/s11145-009-9163-0

McCutchen, D., Harry, D. R., Cox, S., Sidman, S., Covill, A. E., & Cunningham, A. E. (2002). Reading teachers' knowledge of children's literature and English phonology. *Annals of Dyslexia*, *52*, 205–228. https://doi.org/10.1007/s11881-002-0013-x

McNeish, D., & Stapleton, L. (2016). The effect of small sample size on two-level model estimates: A review and illustration. *Educational Psychology Review, 28*, 295–314. https://doi.org/10.1007/s10648-014-9287-x

Moats, L. (1994). The missing foundation in teacher education: Knowledge of the structure of spoken and written language. *Annals of Dyslexia*, *44*(1), 81-102. https://doi.org/10.1007/BF02648156

Moats, L. C. (1999). *Teaching reading IS rocket science: What expert teachers of reading should know and be able to do (No. 372)*. Washington, DC: American Federation of Teachers.

Moats, L., & Foorman, B. (2003). Measuring teachers' content knowledge of language and reading. *Annals of Dyslexia*, *53*, 23–45). https://doi.org/10.1007/s11881-003-0003-7

Moats, L., & Lyon, G. (1996). Wanted: Teachers with knowledge of language. *Topics in Language Disorders, 16*(2), 73–86. https://doi.org/10.1097/00011363-199602000-00007

*Miciak, J., Roberts, G., Taylor, W., Solis, M., Ahmed, Y., Vaughn, S., & Fletcher, J. (2018). The effects of one versus two years of intensive reading intervention implemented with late elementary struggling readers. *Learning Disabilities Research & Practice*, *33*(1), 24–36. https://doi.org/10.1111/ldrp.12159

National Center for Educational Statistics (2017). *National assessment of educational progress: The nation's report card.* Washington, DC: U.S. Department of Education. Retrieved from https://www.nationsreportcard.gov

National Reading Panel. (2000). *Teaching children to read: An evidence-based assessment of the scientific research literature on reading and its implications for reading instruction* (National Institute of Health Pub. No. 00-4769). Washington, DC: National Institute of Child Health and Human Development

Phelps, G., & Schilling, S. (2004). Developing measures of content knowledge for teaching reading. *The Elementary School Journal, 105*(1), 31–48. https://doi.org/10.1086/428764

Piasta, S. B., Connor, C. M. D., Fishman, B. J., & Morrison, F. J. (2009). Teachers' knowledge of literacy concepts, classroom practices, and student reading growth. *Scientific Studies of Reading*, *13*(3), 224–248. https://doi.org/10.1080/10888430902851364

Podhajski, B., Mather, N., Nathan, J., Sammons, J., Joshi, R., & Cunningham, A. (2009). Professional development in scientifically based reading instruction: Teacher knowledge and reading outcomes. *Journal of Learning Disabilities, 42*, 403–417. https://doi.org/10.1177/0022219409338737

Scammacca, N., Roberts, G., Vaughn. S., Edmonds, M., Wexler, J., Reutebuch, C. K., & Torgesen, J. K. (2007). Interventions for adolescent struggling readers: A meta-analysis with implications for practice. Portsmouth, NH: RMC Research Corporation, Center on Instruction.

Scammacca, N., Roberts, G., Vaughn, S., & Stuebing, K. (2015). A Meta-analysis of interventions for struggling readers in grades 4–12: 1980–2011. *Journal of Learning Disabilities*, *48*(4), 369–390. https://doi.org/10.1177/0022219413504995

Scott, T., Alter, P., & Hirn, R. (2011). An examination of typical classroom context and instruction for students with and without behavioral disorders. *Education and Treatment of Children, 34*, 619–641. https://doi.org/10.1353/etc.2011.0039

Shulman, L. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review, 57*(1), 1-23. https://doi.org/10.17763/haer.57.1.j463w79r56455411

Snidarich, S. M. (2015). *Examining effects of a repeated reading intervention and predictive effects of student inputs* (Doctoral dissertation). Retrieved from https://conservancy.umn.edu/

Snijders, T. A. B., & Bosker, R. J. (2012). *Multilevel analysis: An introduction to basic and advanced multilevel modeling*. Thousand Oaks, CA: Sage.

Spear-Swerling, L., & Brucker, P. O. (2004). Preparing novice teachers to develop basic reading and spelling skills in children. *Annals of Dyslexia*, *54*(2), 332–364. https://doi.org/10.1007/s11881-004-0016-x

Spear-Swerling, L., Brucker, P., & Alfano, M. (2005). Teachers' literacy-related knowledge and self-perceptions in relation to preparation and experience. *Annals of Dyslexia, 55*, 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 and Writing*, *25*(7), 1691–1723. https://doi.org/10.1007/s11145-011-9338-3

Stanovich, K. (1986). Matthew effects in reading: Some consequences of individual differences in the acquisition of literacy. *Reading Research Quarterly, 21*, 360–407. https://doi.org/10.1598/RRQ.21.4.1

Szadokierski, I., & Burns, M. (2008). Analogue evaluation of the effects of opportunities to respond and ratios of known items within drill rehearsal of Esperanto words. *Journal of School Psychology, 46*, 593–609. https://doi.org/10.1016/j.jsp.2008.06.004

Tabachnick, B. G. & Fidell, L. S. (2013). *Using multivariate statistics* (6th ed). Boston, MA: Pearson Education.

Torgesen, J. K, Wagner, R. K., & Rashotte, C. A. (2012). *Test of Word Reading Efficiency, Second Edition.* Austin, TX: Pro-Ed.

Toste, J., Capin, P., Williams, K., Cho, E., & Vaughn, S. (2019). Replication of an experimental study investigating the efficacy of a multisyllabic word reading intervention with and without motivational beliefs training for struggling

readers. *Journal of Learning Disabilities*, *52*(1), 45–58. https://doi.org/10.1177/0022219418775114

Vaughn, S., Linan-Thompson, S., Kouzekanani, K., Bryant, D. P., Dickson, S., & Blozis, S. A. (2003). Grouping for reading instruction for students with reading difficulties. *Remedial and Special Education, 24*, 301–315.

Vaughn, S., Roberts, G., Miciak, J., Taylor, P., & Fletcher, J. (2019). Efficacy of a word- and text-based intervention for students with significant reading difficulties. *Journal of Learning Disabilities*, *52*(1), 31–44. https://doi.org/10.1177/0022219418775113

Vaughn, S., & Wanzek, J. (2014). Intensive interventions in reading for students with reading disabilities: Meaningful impacts. *Learning Disabilities Research & Practice*, *29*(2), 46–53. https://doi.org/10.1111/ldrp.12031

Vaughn, S., Wanzek, J., Murray, C. S., Roberts, G. (2012). Intensive interventions for students struggling in reading and mathematics: A practice guide. Portsmouth, NH: RMC Research Corporation, Center on Instruction.

Vaughn, S., Wanzek, J., Wexler, J., Barth, A., Cirino, P., Fletcher, J. M…., & Francis, D. J. (2010). The relative effects of group size on reading progress of older student with reading difficulties. *Reading and Writing: An Interdisciplinary Journal, 23,* 931-956.

Vellutino, F. R., Fletcher, J. M., Snowling, M. J. and Scanlon, D. M. (2004), Specific reading disability (dyslexia): what have we learned in the past four decades? *Journal of Child Psychology and Psychiatry, 45*(1), 2-40. https://doi.org/10.1046/j.0021-9630.2003.00305.x

Wanzek, J., & Vaughn, S. (2008). Response to varying amounts of time in reading intervention for students with low response to intervention. *Journal of Learning Disabilities, 41*(2), 126–142. https://doi.org/10.1177/0022219407313426

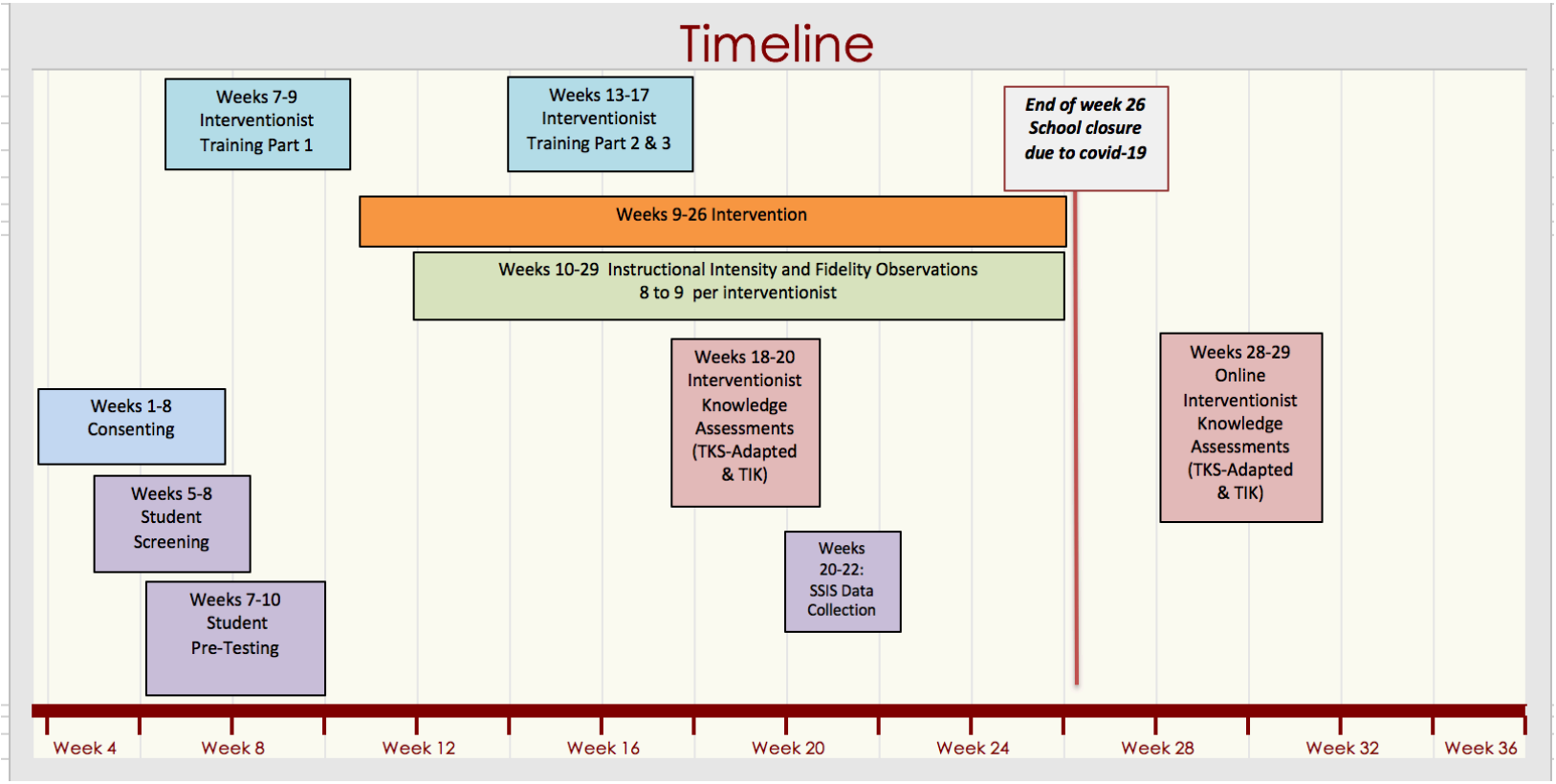
Wanzek, J., Wexler, J., Vaughn, S., & Ciullo, S. (2010). Reading interventions for struggling readers in the upper elementary grades: a synthesis of 20 years of research. *Reading and Writing*, *23*(8), 889–912. https://doi.org/10.1007/s11145-009-9179-5

Washburn, E., Joshi, R., & Binks-Cantrell, E. (2011). Teacher knowledge of basic language concepts and dyslexia. *Dyslexia, 17*(2), 165–183. https://doi.org/10.1002/dys.426

Wills, H., Kamps, D., Abbott, M., Bannister, H., & Kaufman, J. (2010). Classroom observations and effects of reading interventions for students at risk for emotional and behavioral disorders. *Behavioral Disorders, 35*, 103–119. https://doi.org/10.1177/019874291003500

Appendix A.

Timeline



Appendix B.

Instructional Intensity and Fidelity Observation Form

Mindset Grant | LiPS Intervention Fidelity Checklist

General Session Info	
Date	
Observer	
Tutor	
Group Size	

Start Time	
End Time	
Total Time	

Overall (Average) Scores	
Implementation	#DIV/0!
Quality	#
Engagement	#
Mindset	#

Directions:	Rate each component across the four categories (Implementation, Quality, Engagement, and Mindset) using codebook definitions. Use implementation checklists to informally assess teacher progress through the component and inform your code for the broader category. Upload fidelity and lesson plan together.

Component 1: Sound Practice Review (10 min)

Note: Consonants and Vowels will occur at different times. This component requires interventionist to review both.

Start time:	*End time:*	*Start time:*	*End time:*

Implementation Score (3, 2, 1, 0, N/A): #

Consonant Review Checklist	***Vowel Review Checklist***
T uses LiPS materials (mouth pics, letter cards)	*T uses LiPS materials (mouth pics, letter cards, vowel circle/mat)*
T has Ss assemble already reviewed consonant pairs/groups by label.	*T has Ss assemble and order vowel circle, with already reviewed symbols.*
T asks receptive, expressive, and oral questions re: label, letter name, or sound	*T asks receptive, expressive, and oral questions re: label, letter name, or sound*

Expectancy Review Checklist

Start time:		*End time:*	

Review previously taught expectancies and connects to previous sound knowledge re: letters/sounds (e.g., connecting signal e (CVCe) to Ve letter cards).

Notes:

Component 2: Introducing New Concept (5 min) *Note: This may be a consonant(s), vowel(s), expectancy, or multisyllabic word work.*			
Start time:		*End time:*	
Implementation Score (3, 2, 1, 0, N/A):	**#**		
Component 2 Implementation Checklist			
T uses LiPS materials to introduce new concept (e.g., mouth pictures, letter cards; squares for syllables).			
T introduces new concept immediately following relevant review (e.g., signal e after vowel circle)			
T introduces new concept systematically with Discovery Dialogue (see below). ***Consonants:*** *Quiet sound first; quiet letter on left.* ***Vowels*** *: Intro sound, label, order related to other vowels with same label.* ***Expectancy:*** *Uses preexisting schema re: letters/sounds (e.g., connecting signal e (CVCe) to Ve letter cards).* ***Multisyllabic*** *: introduces syllables, accents, or ending grids systematically and connects to previous learning*			
T provides Ss opportunities to practice new concept in isolation and connects to previously reviewed known concepts.			
Notes:			

Component 3: Tracking (5-10 min)			
Start time:		*End time:*	
Implementation Score (3, 2, 1, 0, N/A):	**#**		
Component 3 Implementation Checklist			
T has a planned list of real and nonsense words that includes known or target sounds and sounds that would go together in English (non-example: /z/ /g/). List includes a variety of changes, and each word contains one change.			
T uses LiPS materials (e.g., mouth pictures, chips, tracking mat, syllable squares).			
All students have materials set up the same way (i.e., colored tiles in the same order with tracking mat for 1 syllable or within syllable square for multisyllables, extra tiles in appropriate area on tracking mat, etc.).			
T follows the three step procedure (say old and new word, say and point to the old and new phonemes, make the change).			
For the majority of student errors, T uses at least three of four steps (identify student work, return to old word, say new word again, track correct change)			
Notes:			

RD Dissertation Information

This section is not used for fidelity purposes and will not affect overall fidelity scores or quality scores

Tracking Count: *Total count of words mapped in tracking (real and nonsense).*

Component 4: Spelling and Reading Words (5-10 min)			
Start time:		*End time:*	
Implementation Score (3, 2, 1, 0, N/A):	**#**		
Component 4 Implementation Checklist			
T has a planned list of real and nonsense words that includes known or target letters and letters that would go together in English (non-example: /z/ /g/).			
T uses LiPS materials and/or visual cues (e.g., letter magnets/tiles, lists, syllable part cards, baselines, breaking)			
Reading/spelling list changes include a variety of opportunities and balance between reading and spelling			
For the majority of student errors, T uses at least four of five steps (identifies student work, covers printed word, identifies what should they expect to see given error, checks word, and corrects reading/spelling)			
Notes:			
RD Dissertation Information *This section is not used for fidelity purposes and will not affect overall fidelity scores or quality scores* **Reading/Spelling Count:** *Total word count used in reading and spelling combined.*			

Component 5: Sight Words and Reading in Context (10-20 min)			
Start time:		*End time:*	
Implementation Score (3, 2, 1, 0, N/A):	**#**		
Component 5 Implementation Checklist			
Sight Words/Preview Text*: T pulls Ss to review target sight words while other Ss engage in reading activities/mindset student conference.*			
Student Mindset Conference *: Enter in Component 6*			
Reading in Context*: T brings together whole group to read text as group, using error correction as needed.*			
Reading in Context Preview: *T briefly previews the text (reading the title and/or headings, reviewing key words, discussing text theme or likely events, parts of text important for prediction, etc.)*			
Reading in Context Option 1*: T stops after a meaningful chunk of text (paragraph, page, etc.) and asks Ss to create a gist statement (at least 2 times), and T provides at least 1 opportunity for an inferential question.*			
Reading in Context Option 2*: T stops after a meaningful chunk of text (paragraph, page, etc.) to ask 1 literal comprehension question and repeats with each chunk of text. If applicable, after third correctly answered question, T*			
Reading in Context Mindset Text*: Enter in Component 6 when appropriate*			
Notes:			
RD Dissertation Information *This section is not used for fidelity purposes and will not affect overall fidelity scores or quality scores* **Title of Book:** *Title of the book used in Reading in Context; please note if it is a trade book, Reading A-Z, LiPS Chapter Reader, etc.*			

Starting/Ending Page: *Note the starting page number (and word; if they start in the middle of the page) and ending page number (and*

Component 6: Embedded Mindset
Please Note: This section will be scored according to what was written specifically on the lesson plan. For example, if on the lesson plan T noted that they are only doing language frames and student mindset conferences, those are the only items being scored. The other items would be considered NA when evaluating the overall Component 6 implementation.
Implementation Score (3, 2, 1, 0, N/A): #
Component 6 Implementation Checklist
Lesson Introduction: *T introduces the lesson using embedded script that matches the associated effective effort discussed*
Language Frames: *T uses language frames that match associated effective effort discussed*
Student Mindset Conference *: T pulls S to have a student specific mindset conference* *T uses appropriate effective rubric and associated student mindset conference script if introducing new rubric* *T has student rate their current mindset state using the rubric* *T engages in a brief conversation with S about current mindset state* *T and S make a goal together*
Reading in Context Mindset Text *: THIS IS ONLY TO BE CONSIDERED WHEN MINDSET TEXT IS USED* *T previews the text with activating mindset knowledge (using the prediction starters for ideas).* *T asks specific mindset related questions throughout reading that link mindset themes to the text.* *T asks specific mindset related questions to wrap-up reading in context rather than an evaluative question.*
Lesson Wrap-Up: *T closes out the lesson using embedded script that matches the associated effective effort discussed*
Notes:
Overall Quality Score (3, 2, 1): #
Overall Engagement Score (3, 2, 1): #

Appendix C

Teacher Knowledge Survey, Adapted

Original Version
Shayne B. Piasta
Carol McDonald Connor

Adapted by
Rachel Donegan
Vanderbilt University

Name: _____

Please circle the letter of the best answer.

1. A schwa sound is found in the word
   (a) resume (d) about
   (b) bread (e) flirt
   (c) look

2. Which word contains a short vowel sound?
   (a) treat (d) paw
   (b) start (e) father
   (c) slip

3. A phoneme refers to
   (a) a single letter (c) a single unit of meaning
   (b) a single speech sound (d) a grapheme

4. A pronounceable group of letters containing a vowel sound is a
   (a) phoneme (c) syllable
   (b) grapheme (d) morpheme

5. If *tife* were a word, the letter *i* would probably sound like the *i* in
   (a) if (d) ceiling
   (b) beautiful (e) sing
   (c) find

6. A combination of two or three consonants pronounced so that each letter keeps its own identity is called a
   (a) silent consonant (c) diphthong
   (b) consonant digraph (d) consonant blend

7. A schwa sound is found in the word
   (a) cotton (d) preview
   (b) phoneme (e) grouping
   (c) stopping

8. A diphthong is found in the word
   (a) coat
   (b) boy
   (c) battle
   (d) sing
   (e) been

9. A voiced consonant digraph is in the word
   (a) think
   (b) ship
   (c) whip
   (d) the
   (e) photo

10. Two combined letters that represent one single speech sound are a
   (a) schwa
   (b) consonant blend
   (c) phonetic
   (d) digraph
   (e) diphthong

11. How many **speech sounds** are in the word *eight*?
   (a) two
   (b) three
   (c) four
   (d) five

12. How many **speech sounds** are in the word *box*?
   (a) one
   (b) two
   (c) three
   (d) four

13. How many **speech sounds** are in the word *grass*?
   (a) two
   (b) three
   (c) four
   (d) five

14. Why may students confuse the sounds /b/ and /p/ or /f/ and /v/?
   (a) Students are visually scanning the letters in a way that letters are misperceived.
   (b) The students can't remember the letter sounds so they are randomly guessing.
   (c) The speech sounds within each pair are produced in the same place and in the same way, but one is voiced and the other is not.
   (d) The speech sounds within each pair are both voiced and produced in the back of the mouth.

15. What type of task would this be? "I am going to say a word and then I want you to break the word apart. Tell me each of the sounds in the word *dog*."
    (a) blending (c) segmentation
    (b) rhyming (d) deletion

16. What type of task would this be? "I am going to say some sounds that will make one word when you put them together. What does /sh/ /oe/ say?"
    (a) blending (c) segmentation
    (b) rhyming (d) manipulation

17. Mark the statement that is **FALSE**.
    (a) Phonological awareness is a precursor to phonics.
    (b) Phonological awareness is an oral language activity.
    (c) Phonological awareness is a method of reading instruction that begins with individual letters and sounds.
    (d) Many children acquire phonological awareness from language activities and reading.

18. A reading method that focuses on teaching the application of speech sounds to letters is called
    (a) phonics (d) phonetics
    (b) phonemics (e) either (a) or (d)
    (c) orthography

19. What is the rule for using a *ck* in spelling?
    (a) when the vowel sound is a diphthong (c) when the vowel sound is long
    (b) when the vowel sound is short (d) any of the above

20. Count the number of **syllables** for the word *unbelievable*.
    (a) four (c) six
    (b) five (d) seven

21. Count the number of **syllables** for the word *pies*.
    (a) one (c) three
    (b) two (d) four

The next two items involve saying a word and then reversing the order of the sounds. For example, the word *back* would be *cab*.

22. If you say the word, and then reverse the order of the sounds, *ice* would be
    (a) easy
    (b) sea
    (c) size
    (d) sigh

23. If you say the word, and then reverse the order of the sounds, *enough* would be
    (a) fun
    (b) phone
    (c) funny
    (d) one

24. What is the second sound in the word *queen*?
    (a) u
    (b) long e
    (c) k
    (d) w

25. What is the third speech sound in the word *wretch*?
    (a) /ch/
    (b) /e/
    (c) /t/
    (d) /r/

26. In the word *crouch*, the *cr-* part is called the
    (a) rhyme
    (b) initial phoneme
    (c) rime
    (d) morpheme
    (e) onset

27. In language, a single unit of meaning is called a
    (a) grapheme
    (b) syllable
    (c) rime
    (d) morpheme
    (e) phoneme

28. Count the number of **syllables** in the word *walked*.
    (a) one
    (b) two
    (c) three
    (d) four

29. What type of task would this be? "The word is *taught*. What word would you have if you said *taught* without the /t/ sound?"
    (a) rhyming
    (b) blending
    (c) elision
    (d) none of the above

30. In the word *plan*, the *–an* part is called the
    (a) rhyme
    (b) final phoneme
    (c) rime
    (d) morpheme
    (e) onset

31. For skilled readers, listening and reading comprehension are usually about equal. For developing readers in K-3, it is true that
    (a) Reading comprehension is better than listening comprehension.
    (b) Listening comprehension is better than reading comprehension.
    (c) Reading and listening comprehension are comparable, about the same.
    (d) There is no systematic relationship between reading comprehension and listening comprehension.

32. How many **morphemes** are in the word *gardener*?
    (a) one
    (b) two
    (c) three
    (d) four

33. How many **morphemes** are in the word *unbelievable*?
    (a) one
    (b) two
    (c) three
    (d) four

34. How many **morphemes** are in the word *pies*?
    (a) zero
    (b) one
    (c) two
    (d) three

35. In a closed syllable
    (a) the syllable ends with a vowel and the vowel makes a long sound
    (b) there is a "silent e" at the end of the syllable
    (c) the vowel makes a short sound and is followed by a consonant
    (d) there can be more than one vowel but it is closed in by one or more consonants

36. Which word begins with a short vowel, closed syllable
    (a) inflate (c) eagle
    (b) lotion (d) murmur

37. In an open syllable
    (a) the syllable ends with a vowel and the vowel makes a long sound
    (b) there is a "silent e" at the end of the syllable
    (c) the vowel makes a short sound and is followed by a consonant
    (d) there can be more than one vowel but it is closed in by one or more consonants

38. Which word begins with a long vowel, open syllable?
    (a) favor (c) sunny
    (b) pleasant (d) planet

39. In a VCe (signal-e) syllable, the syllable contains
    (a) one vowel that makes a long sound
    (b) a silent "e" at the end of the syllable
    (c) a vowel that makes a short sound and is followed by a consonant
    (d) more than one vowel closed in by one or more consonants

40. Which word ends with a VCe (signal-e) syllable
    (a) ensure (c) needle
    (b) puzzle (d) inside

41. A prefix and a suffix are
    (a) morphemes that are added to a root or base word that may change the word's part of speech but not its meaning
    (b) free morphemes to which other affixes can be added
    (c) morphemes that cannot stand alone but are used to form a family of words
    (d) morphemes that are added to a root or base word that may change the word's part of speech and its meaning

42. Which word has a prefix?
    (a) definition (c) super
    (b) proactive (d) hamburger

43. Which word has a suffix?
    (a) remain (c) deploy

(b) stall (d) brightly

44. Which word has a prefix and a suffix?
(a) unable (c) mistletoe
(b) replaster (d) requirement

Appendix D

Teacher Intervention Knowledge
(* = Explicit Reading Instruction Item)

Developed by
Rachel Donegan
Vanderbilt University

Name: _____

Please write the letter of the best answer on the line.

_____ 1. Modeling of a new skills should include:

a) demonstrating the skill
b) describing what is being done
c) clear, consistent, and concise language
d) all of the above

_____ 2. After modeling a new skill, you should

a) incorporate practice with support that is gradually faded based on student mastery
b) have the student practice the skill independently
c) administer an assessment before any practice
d) end the lesson and wait to practice the skill till the next day

_____ 3. The purpose of having students practice independently is to

a) provide an ending to the lesson
b) determine if the student can perform a skill without any prompting
c) allow the teacher time to work with other students
d) continue developing an emerging skill

_____ 4. In order to ensure successful practice, a you should

a) provide as many prompts as possible
b) provide prompts targeting areas of a skill where students frequently make mistakes before beginning practice
c) practice simple skills independently and complex skills with prompting
d) all of the above

_____ 5. Which of the following techniques can be used to support student learning when practicing a new skill?

a) asking questions about what they should do

b) providing verbal reminders of what they should do
c) demonstrating what they should do
d) all of the above

_____ 6. When delivering high-quality explicit instruction, it's important to

a) deliver long, detailed explanations without posing questions
b) ask questions frequently throughout instruction
c) ensure all students answer the same number of questions
d) ask questions only when students can complete a task independently

_____ 7. When a student responds to a question incorrectly, you should

a) Wait to provide feedback until the end of the lesson
b) Provide a correction and immediately move on
c) Provide a correction and allow students to practice before moving on
d) Provide only positive feedback

_____ 8. When delivering instruction, the pacing should be

a) Very fast
b) Brisk
c) Slow
d) Determined by teacher preferences and teaching style

_____ 9. You should monitor student learning

a) At the end of lesson
b) During prompted practice
c) During demonstrations
d) Throughout the lesson

_____ 10. When sequencing skills for instruction, it's important to

a) Start with easier skills and once these are mastered move to more difficult skills
b) Start with the most difficult skills first, then move the easier skills
c) Sequence skills according to student preferences for learning
d) Sequence skills randomly

_____ 11*. When teaching students words with a new letter-sound combination, your lesson should include which of the following components?

a) having students read/decode the words with support and then independently
b) demonstrating how to read/decode the words, then having students read/decode a list of words independently
c) demonstrating how to read/decode the words, having students read/decode a list of words together with the teacher, then having students read/decode another list independently
d) demonstrating how to read/decode the words and having students read/decode a list of words together with you

_____ 12*. You are teaching students a strategy for reading multisyllabic words. Before you have students use the strategy to read words, you should

a) explain how to use the strategy without demonstrations
b) demonstrate the steps of the strategy without an explanation
c) explain how to use the strategy then demonstrate the steps of the strategy by using it to read a word
d) explain how to use the strategy without a demonstration, then test students on their understanding of your explanation

_____ 13*. This week, you are teaching students how to read words with vowel combinations. In your lesson today, you are focusing on the vowel combination ea. So far, you have played a game where students draw cards with ea words from a pile and read them together as a group. Before ending the lesson and moving on to the next vowel combination, you should

a) have students read words that contain ea independently to assess their learning
b) have students spell words that contain ea independently to assess their learning
c) play another game to teach students irregular words that contain ea
d) play a game to review all previously taught sounds

_____ 14*. You are preparing students to read a list of words with different vowel combinations you have previously taught. You know from previous lessons that your students struggle to read words with ou. You should

a) remove words with ou from the word list
b) tell the students to practice the words on their own before reading them aloud
c) remind students the sound /ou/ makes immediately before they read the word list
d) not provide any prompts in order to encourage independence

_____ 15*. You are with a reading group of 5 students and want to increase the amount of reading practice each student gets while still being able to monitor their performance. During reading group, you should

a) engage in round robin reading while monitoring student reading and attention
b) have the students silently read the passage while monitoring student attention
c) have students read with a partner while monitoring student reading
d) read the passage aloud to students while monitoring how well students are following along

_____ 16*. During the word reading portion of a lesson, your student reads two out of ten words incorrectly. Both of the words contain closed syllables. How should you respond?

a) Correct errors immediately after they occur for each word by reviewing closed syllables and having students read the missed words again
b) Allow the students to continue reading without correcting errors since 80% accuracy shows they have mastered the skill
c) Wait until the student finishes reading the entire list and then correct errors by reviewing closed syllables and having students read the missed words again
d) All of the above are appropriate responses

_____ 17*. You are planning several months of lessons for fifth-grade readers with significant reading difficulties. Assessment data shows that these students struggle to read words that contain short vowels e and i, vowel combinations ea and oa, and suffixes like -ion and -ment. In what order should these skills be taught?

a) vowel combinations, short vowels, suffixes
b) suffixes, vowel combinations, short vowels
c) Short vowels, suffixes, vowel combinations
d) Short vowels, vowel combinations, suffixes

_____ 18*. You've modeled a strategy for using word parts (e.g. prefixes and suffixes) to read multisyllabic words. Your next step should be

a) having the students use the strategy to read a list of words by themselves
b) having students spell multisyllabic words using word parts they know
c) modeling another strategy for reading multisyllabic words since this strategy doesn't work for all words
d) having students read multisyllabic words using the strategy together as a group while reminding them of the steps

_____ 19. The most common area of difficulty for students with reading disabilities is

a) language
b) decoding and word reading
c) vocabulary
d) motivation

_____ 20. Students with reading disabilities may have difficulties in

a) word reading
b) comprehension
c) phonemic awareness
d) all of the above

_____ 21. Students with reading disabilities frequently

a) have difficulty monitoring their comprehension while reading
b) see letter backwards
c) have below average cognitive abilities
d) outgrow their reading difficulties

_____ 22. For students with reading disabilities, difficulties in word reading may be caused by

a) deficits in visual perception and tracking
b) deficits in general intelligence and learning abilities
c) poor instruction
d) deficits in recognizing and manipulating the sounds in words

_____ 23. Students with reading disabilities often show difficulties with other skills including

a) memory
b) assessing their own learning and performance
c) flexible thinking
d) all of the above