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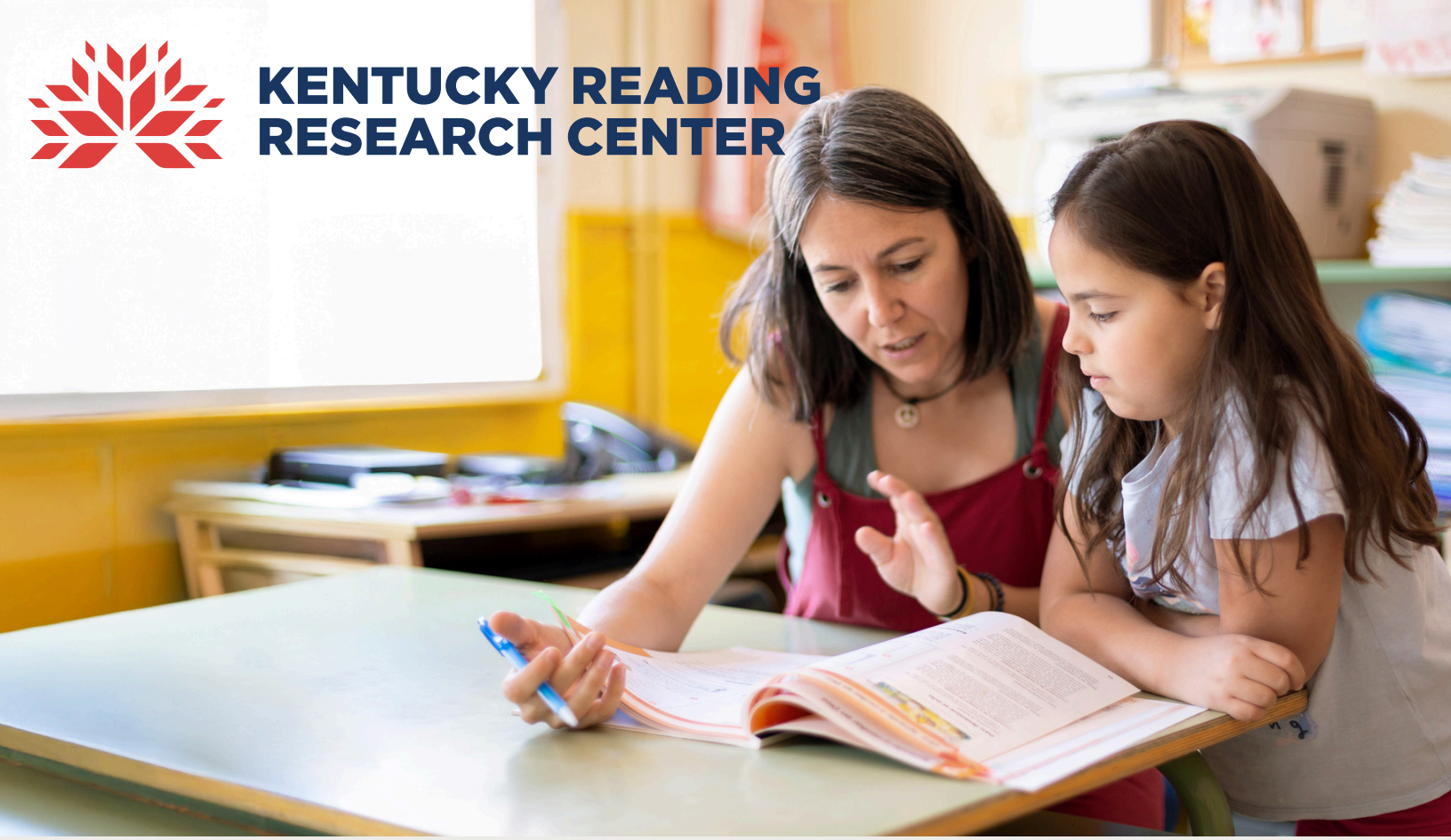

The Effects of Phonological and Phonemic Awareness Interventions: A Systematic Review

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Jennifer Albro, Ph.D.

Education Consultant, Albro Consulting | Flagstaff, Arizona

Doctor of Philosophy, University of Maryland | College Park, Maryland
Literacy, Language, and Social Inquiry

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Abstract

A key element in early reading development is phonological and phonemic awareness, and explicit instruction is necessary to the development of these sound-based skills (National Reading Panel, 2000). The goal of this review was to examine the effects of interventions for K-3 students to determine the instructional characteristics and features that are effective in building phonological and/or phonemic awareness skills for early elementary students. Data were collected and analyzed from 35 experimental, quasi-experimental, or single case primary studies and found multimodal explicit instruction delivered daily for 20-30 minutes in whole-class settings for students in general education classrooms had effective outcomes for early literacy skills. When multimodal, explicit, and systematic instruction targeted code-based skills in small groups or one-on-one settings for 20-30 minutes each day, multilingual learners, students with disabilities, and at-risk students achieved phonological, phonemic awareness, or word decoding skills. Computer-based instruction for early literacy skills also produced effective results across all student groups.

Phonological and Phonemic Awareness

Introduction

Phonological awareness is the ability to recognize and manipulate words that make up sentences, syllables within a word, or individual spoken sounds (e.g., phonemes) within a word (National Reading Panel, 2000). Rehfeld et al. (2022) define phonological awareness as “a broad meta-linguistic skill that represents an understanding that words can be broken into smaller units” (p. 1178). Nested under the broader phonological awareness category, phonemic awareness (PA) is the ability to isolate or manipulate individual sounds (phonemes) in spoken words in order to blend the sounds, segment the sounds, or to delete, add, or substitute sounds within words (Ehri et al., 2001). While phonological awareness is highly correlated to later reading success, research suggests that the ability to manipulate sounds at the phoneme level, or PA, is a stronger predictor of sustained reading success (Ehri et al., 2001; Melby-Lervag et al., 2012; Suggate, 2016). This systematic review includes both phonological awareness and PA, thus, it is important to note the differences in the definitions and how each set of skills impact reading development.

In order to decode words, students must be able to identify sounds associated with graphemes to then blend the sounds to read the word in print. The basis of decoding skills begins with PA skills and the ability to manipulate sounds that make up words. Further, the ability to encode or to spell words begins with segmenting skills and students' understanding of phoneme-grapheme correspondence. The goal of this systematic review is to synthesize effective instructional techniques from the results of studies that have examined PA interventions.

In their meta-analysis that examined PA instruction in preschool through first grade, Rice et al. (2022) found teachers, computer programs, and parents to be effective at providing instruction for at-risk and low-risk students. Rice and colleagues also found group size, duration, the PA skills taught, use of letters, grade level, reading difficulty status, and multilingual learner (ML) status were not significant factors in the outcomes of effective PA instruction.

Rehfeld et al. (2022) investigated the outcomes of PA interventions given to students who were suspected of having a reading disability. Their meta-analysis found medium effects for the composite PA outcomes (g = .511) and segmenting outcomes (g = .571). Further, they found small effects for blending (g = .341), first sound identification (g = .428), and deletion (g = .248). The strongest instructional effects were for kindergarten (K) and first grade participants. They did not find that cumulative intervention intensity had a significant correlation to the student outcomes.

Ehri and colleagues (2001) investigated the effects of PA instruction on both PA and reading skills. They discovered a large effect size (d = .86) for PA instruction on PA skills and a moderate effect size (d = .53) for PA instruction on reading skills. Overall, they found a strong transfer from PA instruction to students' ability to decode words (d = .56). For particular student groups, they found large effect sizes for at-risk students (d = .95) and students on grade-level for reading (d = .93) demonstrating that both of these student groups responded similarly to the PA instruction. For students with disabilities, they found a moderate effect (d = .62) of PA instruction on their PA skills. Many of the samples of students with disabilities were older and they may have already mastered some of the skills prior to the study so the gains may have been less compared to younger students. Further, the skills they were taught may have also been more advanced (e.g., substitution vs. blending) which are harder to master.

Suggate (2016) examined the long-term effects of PA interventions and found overall a small effect size for PA instruction eleven months after participation demonstrating the sustained effects of the intervention. Suggate found intervention type and grade were critical moderators of the sustained intervention effects. For the follow-up effect sizes, they decreased for the younger grades (PreK, K) and increased for the older grades (third and fourth). In contrast to the results from Ehri et al. (2001), Foorman et al. (2016), and Melby-Lervag et al. (2012), Suggate found the inclusion of letters when teaching PA to not be a significant long-term outcome; however, PA interventions had more effective long-

term effects than phonics interventions. Finally, Suggate also found the long-term effects were greater for students with disabilities and at risk for reading difficulties than compared to students performing on grade-level for reading skills.

In the What Works Clearinghouse (WWC) practice guide for foundational skills for reading, Foorman et al. (2016) investigated 17 studies that tested interventions designed to support students in building awareness of phoneme segments and phoneme-grapheme correspondence. They found strong evidence of three distinct practices that had positive outcomes on students' letter knowledge, letter sounds, and phonology. These practices include: 1) Teach students to recognize and manipulate segments of sound in speech, starting at the word level and moving to the phoneme level; 2) Teach letter-sound correspondences, starting with individual letters and moving to blends, digraphs, and more complex graphemes; and 3) Use word building and other activities (e.g., word boxes, letter tiles, etc.) to link students' letter-sound knowledge with PA (e.g., isolating, deleting, and substituting sounds within words).

Factors Affecting Phonological and Phonemic Awareness

As of May 2024, the National Center for Education Statistics (NCES) reported that the number of students identified as a ML has increased from 9.4 percent (4.6 million) in 2011 to 10.6 percent (5.3 million) in 2021. The percentages of MLs are greater in the primary grades. For example, the percentages of public school students who were identified as MLs by grade include: 14.7 percent in K; 15 percent in first grade; 14.9 percent in second grade; and 14.4 percent in third grade. By the 12^{th} grade, the percentage drops to 6.1. Research suggests that students who are learning an additional language may have an advantage in developing PA in that language (Foorman et al., 2017; Wren & Hambly, 2011). Given the higher percentages of MLs in the primary grades when phonological and PA skills are taught and developed, it is important for teachers to be aware of their students who are MLs as their language and literacy abilities in their native language may be an asset in learning phonological and PA skills.

In their review on the impact of bilingualism and PA skills, Wren and Hambly (2011) found that some bilingual students with typical speech development may have an advantage in developing PA skills. Nine out of their 13 reviewed studies compared PA in bilingual and monolingual students. None of those 9 studies found consistent evidence that monolingual students performed better than bilingual students on the PA tasks. Three of the 13 studies identified a positive transfer of PA skills for bilingual students compared to monolingual students. Their overall findings show that bilingual students performed the same or better than monolingual students on phoneme deletion, segmentation, isolation, blending, and substitution tasks. Because MLs are asked to use PA skills more frequently as they learn multiple languages, they may have an advantage in performing PA tasks. Wren and Hambly (2011) write, "Phonemic awareness skills are believed to transfer across languages. Given the increased practice that bilingual children receive in phonemic awareness … it is feasible that they could develop a greater range and speed of phonemic

awareness skills for use with all their languages compared to their monolingual peers" (p. 20).

Using a randomized control trial with at-risk students in grades K through second grade, Foorman et al. (2017) compared two interventions, a standalone intervention that combined a reading component and two oral language components and an embedded intervention that involved a reading component and one oral language component embedded into the core curriculum. One of their aims was to explore differences in outcomes for each intervention based on English-learner status. They found MLs in K had greater outcomes in the embedded intervention than in the standalone (effect size = .32). They hypothesize that the comprehension strategies embedded in the core instruction may have been a scaffold to help them to identify and segment spoken sounds.

Another factor that affects the development of PA is related to the phonological processor and phonological working memory in the brain. The phonological processing system is located in multiple parts of the brain, including the frontal lobe, parietal lobe, and temporal lobe, and it is responsible for recognizing, recalling, and producing sounds withing a speech-sound system (Moats & Tolman, 2019). Due to how their brains are wired, some students have difficulties in their phonological processor which impacts their ability to identify, remember, manipulate, or produce sounds (Suggate, 2016). Moats and Tolman (2019) write, "students who have trouble with phonological processing show a variety of symptoms, such as difficulty remembering sounds for letters or blending them together, difficulty recognizing the subtle differences between similar sounds and words, and trouble spelling all the speech sounds in a word" (p. 30).

Given that phonological deficits in the brain can impact the ability to recognize and produce sounds which are the foundation for decoding, it is important to understand the percentage of students who may experience this struggle with phonological processing. According to NCES, in the 2022-23 school year, 32% of students identified with a disability had a specific learning disability (NCES, 2024b) and dyslexia and other neurobiological disabilities fall under this category. The International Dyslexia Association (IDA) estimates that 15-20% of the world's population experience the symptoms of dyslexia (e.g., slow rates of reading, inaccuracy in reading, and struggles with spelling and writing) even if they are never officially diagnosed.

In their meta-analysis that examined the relationships among phonological skills and word reading skills, Melby-Lervag et al. (2012) reviewed 235 extreme group or correlational studies and calculated 995 effect sizes. They found a large correlation effect (r = .57) between PA and word reading, and PA was the only independent predictor of reading outcomes. Similar to other studies (Foorman et al., 2016), they suggest that when PA instruction is paired with code-based reading instruction, students have greater success in word reading skills. In other words, the more instruction can include both PA skills such as blending and segmenting with letters or graphemes, the better students will be able to decode words. They argue that a critical foundation of decoding is the "development of

phonemically structured phonological representations and "a failure to develop [these representations] is a principal cause of the difficulties in learning to read experienced by children with dyslexia" (p. 341). Providing students with explicit instruction in PA skills in tandem with teaching the alphabetic principle is critical to addressing phonological processing factors related to decoding.

According to the WWC practice guide for foundational skills to support reading, the second recommendation that had strong evidence, specifically suggested for K and first grade students, is to "develop awareness of the segments of sound in speech and how they link to letters" (Foorman et al., 2016, p. 14). In the WWC practice guide, Foorman et al., (2016) name two obstacles to implementing this recommendation: 1) "many students mix up letter shapes and sounds" and 2) "some students have consistent problems with phonological awareness" (p. 21). For the first obstacle, the panel suggests teaching single letters and using repetition until students reach mastery; then gradually introduce more letters and teach students to differentiate and identify letters within a group of other letters. The panel also recommends introducing handwriting to help students identify letter shapes by developing hand-eye coordination so letter transcription and identification can become automatic. For the second obstacle, the panel advises using early intervention and one-on-one or small grouping to help students isolate spoken sounds and connect those sounds to corresponding letters or graphemes.

Barriers

At the student, teacher, and school level, there are barriers to providing high-quality instruction for phonological and PA. Some of those barriers include: a) limited instruction due to lack of training and resources for teachers; b) limited instructional time; and c) ensuring student access to the appropriate intervention (e.g., tier 2, tier 3) with an appropriate implementer.

It has long been established that explicit instruction is critical to the development of PA skills (Ehri et al., 2001; Wilson, 1998). Teachers who are tasked with providing PA instruction need to have the necessary training and resources, including a high-quality curriculum with a scope and sequence and valid and reliable assessments to measure the effects of their instruction. Ehri et al. (2001) found "that when teachers are given instruction, they can learn to teach PA adequately" (p. 279). They suggest teachers and other intervention implementers need to know about how PA develops in students, the levels of difficulty and progression of PA skills, how to provide corrective feedback when students make common mistakes, and content around phonemes, graphemes, and the alphabetic principle and orthography. Districts and schools that can provide the necessary curricular resources and training will be better equipped to deliver the high-quality instruction to students to develop their PA skills which will support their word decoding and reading fluency abilities.

Another barrier to providing phonological or PA instruction is the limited instructional time within school schedules. Most schools in the United States build in 90 to 120 minutes total each day into a literacy block. Within this block, teachers must teach foundational code-based skills including PA and phonics and knowledge-based skills of vocabulary, background knowledge, and comprehension. Because PA skills should not be taught in isolation and should be applied to other skills such as teaching sounds with letters, lower doses of regular and targeted instruction can be highly effective for reading outcomes. For example, Ehri et al. (2001) found the largest effect sizes for PA instruction that lasted between 5 and 18 hours in total and suggested that regular sessions be limited to 30 minutes or less. At the maximum of 18 hours (1,080 minutes) over the course of a 180-day school year, teachers would need to deliver PA instruction for 6 minutes each day. Further, if teachers maximize the instructional time by combining both PA skills with phonics and decoding skills, students may experience stronger outcomes on word reading. Another way to address the barrier of limited instructional time is to use PA assessments to further focus and target instruction. Finally, it is important to keep the goal of decoding and reading in mind when teaching PA; learning PA skills is not the goal in and of itself but to be able to apply those skills to blending sounds to read words or segmenting sounds to spell words.

Lastly, ensuring students are matched with the appropriate tier of instruction (e.g., instructor, group size, dosage, etc.) can be a barrier to phonological or PA outcomes. Ensuring schools are staffed with specialists/interventionists and that other implementers are trained to support targeted literacy instruction can be a barrier to students receiving the instruction they need. Ehri et al. (2001) found a strong correlation between small group instruction and PA outcomes and noted the correlation not causation. Suggate (2016) found that one-on-one interventions were not consistently correlated with larger effect sizes suggesting that students who are regularly identified to receive tier 3 interventions –often students with a disability—may benefit from instruction delivered in a different setting. Suggate writes, "…it would appear more important that students in need receive the appropriate services, with it being less important if these are offered in individual or small-group settings" (p. 49). Hall and Burns (2018) reviewed studies with targeted small-group reading interventions and found interventions that focused on a targeted skill were more effective (g = .65) than interventions that taught multiple skills in a comprehensive approach (*g* = .35). Overall, they found small group reading interventions were moderately effective (*g* = .54) and researchers or hired interventionists were more effective in delivering the interventions than teachers within the school. Hall and Burns note that the researchers and interventionists may have had specific training related to the intervention emphasizing the importance of providing high-quality training and development for anyone providing an intervention.

Research Questions:

1. What instructional and intervention characteristics (e.g., use of Elkonin boxes, multicomponent instruction, intervention dosage, group size, implementer,

modality) and student characteristics (e.g., age, ML, disability status) have been tested as part of phonological awareness or PA interventions?

2. What does the research say about the effectiveness of phonological awareness or PA instruction in improving foundational reading outcomes for readers in grades K-3?

3. What features of instructional interventions (e.g., type of instruction, duration, grade level) are associated with improved outcomes? Do these features differ according to student characteristics?

Method

Study Eligibility Criteria

Literature was identified through a three-step process. First, studies were identified based on key search terms. Next, the titles and abstracts were screened for eligibility. Third, a full-text screening process based on eligibility criteria was implemented. To be included in the review, studies must have met the following criteria: a) an experimental research design; b) at least 50% of the student sample in grades K-3; c) a reading-focused intervention with student outcomes; d) written in English and the study took place in the United States or its territories, England, Australia, Ireland, New Zealand, or Canada in a school-based setting, public or private, classroom, clinic, home, or early childhood center; and e) at least one outcome was related to phonological awareness or PA.

Search Strategy

In the identification process, an electronic database search was conducted using ERIC (EBSCO), Academic Search Complete, APA PsycINFO, Teacher Reference Center, and Education Full Text. The search terms were developed based on the following categories: study design (e.g., randomized control trial (RCT), experimental); topic (e.g., PA, blending, segmenting); intervention (e.g., strategy, program); population (e.g., K-3, ages 5-9); and outcome (e.g., effect, improvement). Other exclusion criteria included the timeframe and publication type. Studies must have been published between 2014 and January 2025 when the search was conducted. Conference papers and dissertations were not eligible for inclusion. Studies related to teacher professional development or teacher preparation were not included.

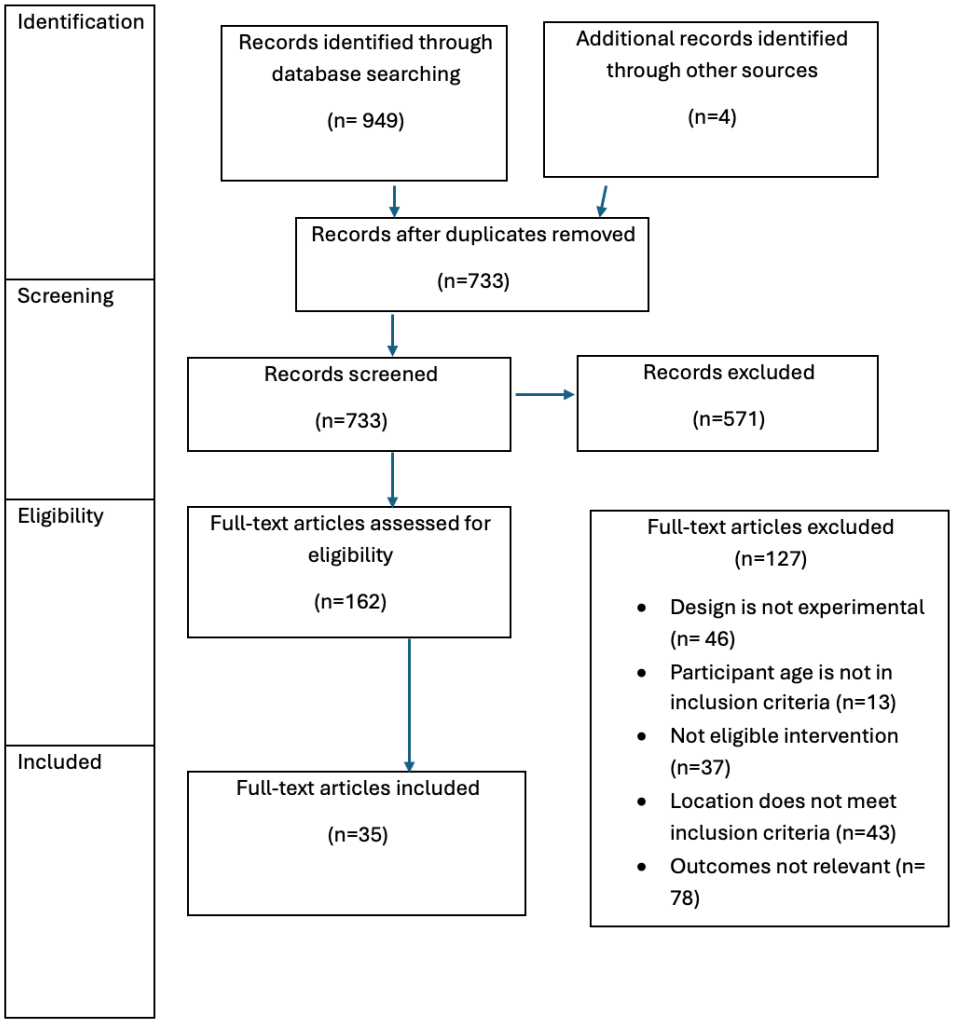
The database search produced 949 records. Once duplicates were removed, 733 records remained. The titles and abstracts of the 733 records were screened for the eligibility criteria and sorted into two categories (“yes” or “no”). Using 200 records as a sample to obtain reliability, two researchers screened the records and ensured a 90% agreement percentage. Any disagreements were resolved via a discussion. From the screening phase of the process, 571 records were excluded leaving 162 eligible for full-text screening.

The 162 records eligible for full-text screening were reviewed and included if they had the following criteria: a) an experimental research design; b) at least 50% of the student sample in grades K-3; c) a reading-focused intervention with student outcomes; d) written in English and the study took place in the United States or its territories, England, Australia, Ireland, New Zealand, or Canada in a school-based setting, public or private, classroom, clinic, home, or early childhood center; and e) at least one outcome was related to phonological awareness or PA. A spreadsheet was used with "yes" or "no" coding; if one criterion was missing, the record was excluded. From this process, 127 records were excluded leaving 35 records to be synthesized in this systematic review.

After completing the database search, prior literature reviews and meta-analyses related to phonological awareness or PA were reviewed. The studies in prior reviewed were cross-referenced with the studies included for final inclusion and against the inclusion criteria. Four records were included based on the cross-reference screening process.

Figure 1 includes a PRISMA diagram that outlines the selection process.

Figure 1. PRISMA diagram



Inclusion and Exclusion Criteria

The following includes a more in-depth description of the eligibility criteria:

1. *Study design:* Included studies used an experimental research design with a control group. If a study did not have a control group, it was excluded. Correlation studies were not included.
2. *Participant sample:* Included studies had at least 50% of the student sample in grades K-3. Studies with MLs and students with disabilities (SWD) students were included.
3. *Intervention:* Included studies had a reading-focused intervention, specifically related to PA, with student outcomes. If teacher outcomes were included, the study was excluded. Studies that had instruction implemented by a researcher, classroom teacher, interventionist, special education teacher, paraprofessional/aide, parent/caregiver, or computer program were included.
4. *Language and study location:* Included studies were written and conducted in English and the study took place in the United States or its territories, England,

Australia, Ireland, New Zealand, or Canada in a school-based setting, public or private, classroom, clinic, home, or early childhood center. Studies with MLL students were included.

5. *PA outcomes:* Included studies had at least one outcome related to phonological awareness or PA skills. PA skills included rhyming, syllable identification, blending, segmenting, phoneme identification, isolation, deletion, and/or substitution. Studies that included the use of letters or graphemes to identify phonemes or to teach blending and segmenting to read individual words were included. Studies that went beyond the single word level were excluded.

Coding Procedure

The 35 records included in the final analysis were coded using a spreadsheet to extract information on the following categories: a) research design; b) instructor/intervention implementer type; c) student demographics and participant information; d) independent variable name and description; e) dependent variable(s) and description; f) effect size/outcome; g) fidelity of research; and h) instructional setting and dosage including intervention and control conditions.(See appendix A for complete list of included studies).

Analysis

After the 35 studies were coded by extracting the key information, the results were categorized into three tables to synthesize the studies' findings. The first table included the study design, implementer type (e.g., tech, teacher, researcher), student participant sample demographics and size, intervention type (e.g., researcher created or established program/curricula), and intervention dosage. The second table captured all of the components in the intervention, including the skills and strategies taught (e.g., blending, segmenting) and instructional techniques used (e.g., explicit instruction, finger stretching, Elkonin boxes). The third table synthesized the intervention and comparison/control elements, the outcomes, data analysis methods, and the intervention tier (e.g., tier 1, tier 2, or tier 3). Tier 1 interventions were given to the entire class in a whole group setting. Tier 2 interventions were provided in small group settings, typically 3-5 students per group. Tier 3 interventions were delivered in a one-on-one setting either by a teacher or individually on a computer or technology device.

After the three tables were completed, they were color coded to organize and synthesize the studies starting with the outcomes for phonological awareness or PA. The information from the three tables were then transferred into one spreadsheet. With the information in one spreadsheet, filters and dropdown menus were used to clean the data to be able to sort and analyze based on the categories. For example, the studies were sorted by the outcomes of the dependent variables to identify the characteristics of the instruction, grouping, student demographics, implementer, etc. that were effective and ineffective. From there, the results were presented based on the outcomes and the effect sizes. Once the studies were categorized based on the effectiveness of PA instruction in improving

foundational reading outcomes, they were further analyzed to explore the effectiveness for SWD, students at-risk of reading difficulties, students in general education, MLs, and interventions implemented in tier 1, 2, and 3. Using the outcome categories of phonological awareness, PA, blending, segmenting, deletion, substitution, letter sound fluency, and decoding, the subcategories of tiered instruction and student demographics were sorted to identify patterns.

Results

Characteristics of Reviewed Studies

The first research question sought to identify what instructional elements of phonological awareness and PA have been investigated between 2014 and January 2025.

> *Research Question 1:* What instructional and intervention characteristics (e.g., use of Elkonin boxes, multicomponent instruction, intervention dosage, group size, implementer, modality) and student characteristics (e.g., age, ML, disability status) have been tested as part of phonological awareness or PA interventions?

To address this question, the 35 studies were analyzed and the characteristics are presented below. Table 1 includes an overview of the reviewed studies and their characteristics. Figure 1 provides the frequency of the instructional techniques used by the implementer (e.g., explicit instruction, corrective feedback, etc.) and Figure 2 includes an overview of the instructional components coded within one of the five pillars of reading or writing. Figure 3 synthesizes the occurrences of the instructional components (e.g., blending, letter sounds, etc.) that occurred within the code-based instructional pillars of fluency, phonics, and PA.

Out of the 35 studies, eight used a RCT, sixteen used a quasi-experimental design (QED), and eleven used a single case design (SCD). Nineteen included student participants who were identified as at risk and requiring more intervention. Seventeen studies included student participants who were identified as SWD. Fourteen studies included student participants who were identified as EL or ML. Seven were studies that included both MLs and SWD.

Ten of the 35 studies used some form of technology to implement the intervention. These included software on a computer such as Reading Doctor, applications on a computer or an iPad such as Lexia, or researcher-created programs that involved student participants interacting with technology (e.g., apps, PowerPoint, etc.). Fifteen of the 35 studies had interventions implemented by a researcher or a team of researchers only or a researcher in tandem with technology or teachers. Out of the 35 studies, 20 of them had interventions delivered by teachers, which could have been teachers only, teachers and technology, teachers and paraprofessionals or hired interventionists, or teachers and researchers. Only four studies used hired interventionists to deliver the instruction, with

only one of them using interventionists as the sole implementer; the other three studies involved hired interventionists and other instructors (e.g., teachers and paraprofessionals). Four studies involved paraprofessionals as implementers, and they were paired with another instructor or supporting the implementation of technology.

Interventions were delivered in various settings which were identified as tier 1 , tier 2, or tier 3 instructional settings. Tier 1 instruction was delivered to the whole class or a group larger than seven students. Tier 2 instruction was delivered in a small group setting of at least two students and no greater than six students. Tier 3 interventions were delivered in a one-on-one setting with one implementer to one student ratio. Given that interventions involving technology or computers are implemented with one student on one device at a time, these interventions were coded as tier 3 due to the individual nature of the intervention. Out of the 35 studies reviewed, seven of them had tier 1 instruction; 13 offered tier 2 instruction; and 17 of them had tier 3 interventions. Two studies included multiple tiers of instruction (e.g., both small group and individual instruction, tier 2 and tier 3 respectively).

Table 1. Overview and Demographics

Study	Design	Student Characteristics	Implementer	Tier and Dosage	Instructional techniques
Anthony (2020)	RCT	247 K (general education)	Tech and TI	Tier 3 Individual instruction on computer 90 min each week	Explicit instruction, support is gradually removed, finger tapping, verbal prompts and cues, corrective feedback
Cassady et al. (2018)	RCT	1,490 MLs in K (767) and 1st grade (723) 1,341 at risk	Tech	Tier 3 Individual instruction on computer; 20 min sessions 4-5 times per week	Explicit instruction, repeated lessons, visual supports/pictures, corrective feedback
Chai et al. (2015)	SCD	3 2 K and 1 2nd grade; all SWD	RI and Tech	Tier 3 Individual instruction on iPad for 10 min twice a day	Explicit instruction, support is gradually removed, verbal prompts and cues, corrective feedback
Chapman (2016)	QED	104 K all at risk	TI	Tier 1 Whole class instruction for 90 min daily in	Explicit instruction

				reading block for 32 weeks	
Coleman et al. (2021)	SCD	3 2 1st grade and 1 3rd grade; all SWD	RI and Tech	Tier 3 Individual computer-based instruction; Sessions were conducted once per day 4 x week Each session took approximately 5–8 minutes.	Explicit instruction, repeated lessons, visual supports/pictures, verbal cues/prompts
Coyne et al. (2018)	QED/RDD	678 1st, 2nd and 3rd grade; (318 treatment and 360 control) 84 1st grade; 108 2nd grade; 126 3rd grade	HI	Tier 2 Small group instruction; 30-40 min 4 days per week over the course of the school year beginning in mid-November and ending in June.	Explicit instruction
Dussling (2020)	SCD	13 1st grade; 7 MLs and 13 at risk	RI	Tier 2 Small group instruction 30 min 5 times per week for 6 weeks	Explicit instruction, support is gradually removed, word and sentence dictation, visual supports/pictures, verbal cues/prompts, corrective feedback
Fien et al. (2015)	RCT	267 1st grade at risk; 32 were MLs and 14 SWD	TI and Para	Tier 1 and Tier 2 Whole class and small group instruction; 90-min tier 1 reading block and 30-min small group daily for approximately 26 weeks	Explicit instruction, hand signals, finger tapping, word and sentence dictation, verbal cues/prompts, corrective feedback
Flynn et al. (2023)	SCD	23 1st grade all at risk; 2 SWD	RI	Tier 3 Individual instruction 15 min weekly for 20 weeks (6 months)	Explicit instruction, hand signals, finger tapping

Frates et al. (2024)	SCD	2 1 K and 1 1st grade; Both MLs and SWD	RI and TI	Tier 2 Small group instruction for 25-30 min sessions, 19 intervention sessions total	Explicit instruction, word boxes, visual supports/pictures
Fuchs et al. (2021)	QED	491 1st grade; 59 MLs; 34 SWD; 221 at risk	RI and TI	Tier 1 Whole class instruction for 22 weeks	Explicit instruction, teacher read aloud w/ students following along, corrective feedback
Gillon et al. (2019)	RCT/Stepped Wedge	141 K; 39 MLs	TI	Tier 1 Whole class instruction; 20 hours in total (four 30-min sessions per week for 10 weeks)	Teacher read aloud w/ students following along
Gonzalez-Frey and Ehri (2021)	QED	K Study 1: 18; Study 2: 16; Study 3: 38	RI and TI	Tier 3 Individual instruction; 20 min sessions	Explicit instruction, visual supports/pictures, verbal cues/prompts, corrective feedback
Helf et al. (2014)	QED	303 K; all at risk	TI, Para, and HI	Tier 2 Small group instruction daily for 10 min	Explicit instruction, verbal cues/prompts, corrective feedback
Hodgins and Harrison (2021)	QED	24 K, all at risk	TI	Tier 2 Small group instruction; 90 min each week for 10 weeks	Explicit instruction, finger tapping, word boxes
Joseph (2018)	SCD	3 2nd grade; all SWD and considered at risk	RI and TI	Tier 3 Individual instruction 30 min per week	Explicit instruction, word boxes, verbal cues/prompts
Kuppen and Bourke (2017)	RCT	K; Cohort 1 was 98 and in Cohort 2 was 136 (general education)	TI	Tier 1 Whole class instruction 10 min daily for 12 weeks	Hand signals, visual supports/pictures, teacher read aloud w/ students following along

McBreen and Savage (2022)	QED	25 3rd grade (general education)	RI	Tier 2 Small group over the course of 8 weeks during the winter semester of the 2018 school year; groups of 2-5 students, 2-3 lessons per week, each lasting 45 min, for a total of 1.5 to 2.25 hr per week.	Explicit instruction, motivational strategies
Messer and Nash (2018)	RCT	78 2nd all at risk	Tech and Para	Tier 3 Individual computer-based instruction; 10-15 min 2-3 times per week for 10 months	Motivation strategies, visual supports/pictures, verbal cues/prompts, corrective feedback
Metasala and Kalindi (2022)	QED	Year 1 Study: 55 MLs K Year 2 Study: 88 MLs K	Tech and TI	Tier 3 Individual computer-based program instruction; Year 1 Feb to May; Year 2 mid-Nov to May; Average use 41.7 hours (total time to complete program is 80 hours)	Explicit instruction, support is gradually removed, motivation strategies, visual supports/pictures, verbal cues/prompts
Miles et al. (2022)	RCT	Cohort 1: 146 1st grade SWD, MLs, and at risk Cohort 2: 104 1st grade SWD, MLs, and at risk	TI and HI	Tier 2 and 3 Small group and individual instruction 30 min per day 5 times per week	Explicit instruction, verbal cues/prompts
Nicholson et al. (2019)	QED	72 K-4th grade (5 yr 6 months to 10 yr 5 months)	TI, Para, and HI	Tier 3 Individual instruction for 3 weeks during summer reading program	Explicit instruction
O'Callaghan et al. (2016)	RCT	98 K 34 MLs	Tech	Tier 3 Individual instruction on computers for	Explicit instruction, verbal cues/prompts,

				20-30 min daily for 8 weeks	corrective feedback
Olszewski et al. (2018)	SCD	1 3rd grade SWD	RI	Tier 3 Individual instruction twice per week for two intervention cycles (Cycle 1: 7 weeks; Cycle 2: 6 weeks)	Explicit instruction, teacher read aloud w/ students following along
Partanen et al. (2019)	QED	158 3rd grade at risk	Tech and TI	Tier 3 Individual instruction for 3.75 hours per day for 189 hours for the term	Explicit instruction, graphic organizer
Prahl et al. (2022)	SCD	3 2 1st grade and 1 3rd grade; all SWD	RI	Tier 2 Small group instruction for 30 min 3 times per week	Explicit instruction, repeated lessons
Rahn et al. (2015)	SCD	2 1 K and 1 1st grade; Both MLs and 1 SWD	RI	Tier 3 Individual instruction 10-15 min daily for 4 days per week	Explicit instruction, corrective feedback
Ritter et al. (2021)	SCD	3 K	RI	Tier 2 Small group instruction; 30 min 3 days per week for 8 weeks	Explicit instruction, motivational strategies, corrective feedback
Shamir et al. (2018)	QED	3,247 K and 1st grade general education	Tech	Tier 3 Individual computer-based usage; K students were expected to use ERP for 15 min per day, 5 days per week, and 1st grade students were expected to use ERP for 30 min per day, 5 days per week.	Explicit instruction, repeated lessons, word/sound sorts, visual supports/pictures, verbal cues/prompts, corrective feedback
Solari et al. (2018)	RCT	98 1st grade all at risk	TI	Tier 2 Small group instruction 30 min 4 times per week for 17 weeks	Explicit instruction, word boxes, repeated lessons, verbal cues/prompts, corrective feedback

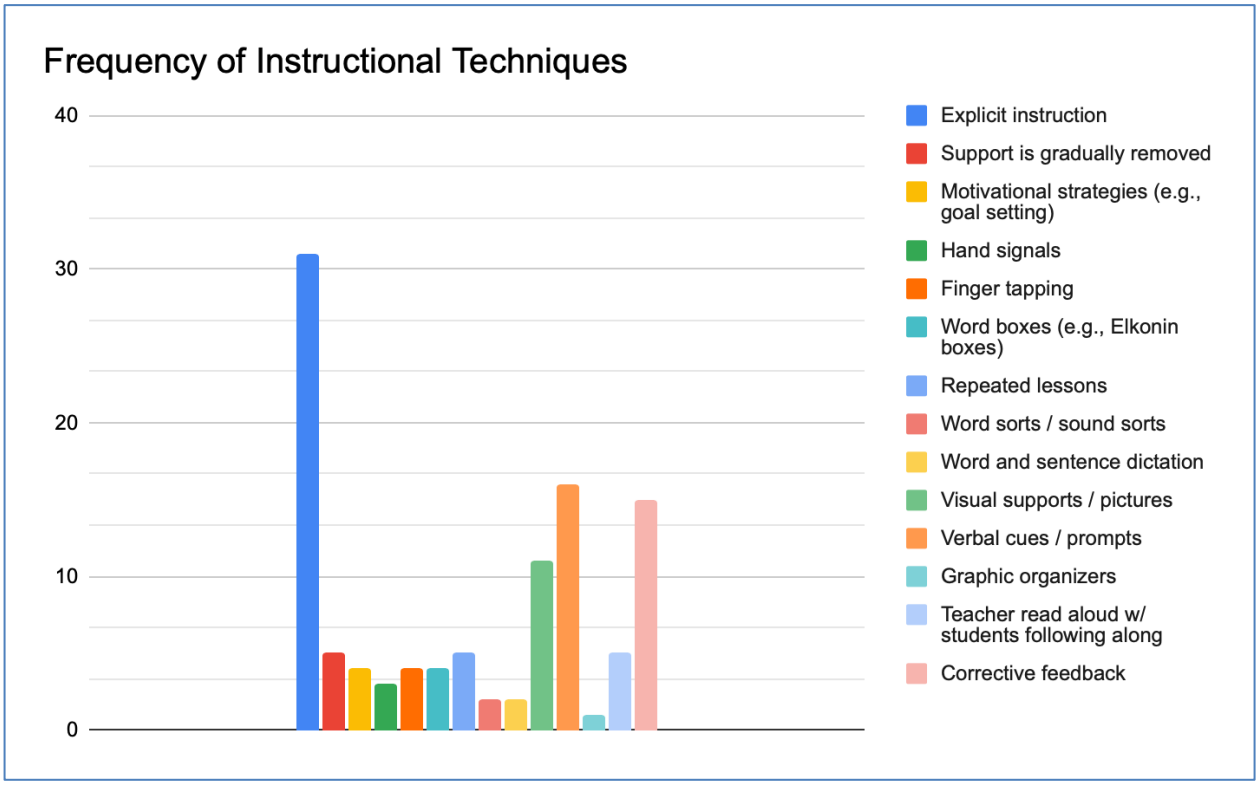
Vollebregt et al. (2021)	QED	90 1st grade	RI and TI	Tier 1 Whole class and small group instruction 50 min 2 times per week	Explicit instruction, verbal supports/pictures, verbal cues/prompts
Wheldall et al. (2016)	QED	240 K	TI	Tier 1 Whole class (Limited to 15 students); 30 min 5 days per week for 25 weeks	Explicit instruction, teacher read aloud w/ students following along
Winn et al. (2020)	QED	24 K-3rd grade all at risk	Tech and TI	Tier 3 Individual instruction on computer/device 20 min per day, 5 days per week, for 12 weeks	Support is gradually removed, verbal cues/prompts, corrective feedback
Wise et al. (2016)	QED	12 1st grade; all at risk and 10 MLs	TI	Tier 2 Small group instruction; 25 min twice per week for 18 weeks (15 hours of total instruction)	Explicit instruction
Zoski and Erickson (2017)	QED	17 K; all at risk, 10 MLs, 2 SWD	RI	Tier 2 Small group instruction; 30 min sessions 4-5 times per week for 6 weeks	Explicit instruction, word/sound sorts, visual supports/pictures

HI= hired implementor, K= kindergarten; MLs= multilingual learners, Para= paraprofessional implemented; QED=quasi-experimental design RCT=randomized controlled trial; RDD=regression discontinuity design;RI= researcher implemented; SCD=single case design; SWD= student with disabilities; Tech= technology implemented; TI= teacher implemented

Out of the 35 studies reviewed, the instructional techniques that were implemented the most included: a) explicit instruction, b) verbal cue and prompts, and c) corrective feedback. Most studies named explicit instruction as a key technique in the intervention, while some studies named "teacher modelling" or "direct instruction" as core aspects of the intervention which were coded under explicit instruction. When the implementer gave the correct answer after a participant gave the incorrect answer, it was coded as "corrective feedback." When the implementer reiterated a direction such as "touch the sound" or "what is the first sound you hear?", it was coded as a verbal prompt and cue. When a study named "multimodal" strategies, they were coded for verbal cues and visual supports. Studies that named games, self-graphing, self-monitoring, or goal setting were

coded as “motivation strategies” for the instructional technique. Figure 1 provides the number of occurrences of instructional practices across the included studies.

Figure 1. Frequency of Instructional Techniques



Independent Variables: Components of Interventions Examined in Synthesis

Table 2. Components

Study	Student Grade(s) and Demographics	Implementer	Tier	Instructional techniques	Intervention components
Anthony (2020)	K; general education	Tech and TI	Tier 3	Explicit instruction, support is gradually removed, finger tapping, verbal prompts and cues, corrective feedback	Recognition and manipulation of phonemes, rhyming, blending, segmenting, general PA skills, letter sounds, onset/rime, decoding
Cassady et al. (2018)	K and 1st grade; MLs and at risk	Tech	Tier 3	Explicit instruction, repeated lessons, visual supports/pictures, corrective feedback	General PA skills, alphabetic principle, decoding, vocabulary instruction, comprehension instruction, oral

					reading, reading connected text
Chai et al. (2015)	3 2 K and 1 2nd grade; all SWD	RI and Tech	Tier 3	Explicit instruction, support is gradually removed, verbal prompts and cues, corrective feedback	Initial sounds ID, general PA skills, letter sounds
Chapman (2016)	K at risk	TI	Tier 1	Explicit instruction	Recognition and manipulation of phonemes, general PA skills, letter sounds, alphabetic principle, encoding, comprehension instruction, reading HFW, writing simple sentences, letter formation
Coleman et al. (2021)	1st and 3rd grade; all SWD	RI and Tech	Tier 3	Explicit instruction, repeated lessons, visual supports/pictures, verbal cues/prompts	Blending, letter sounds, alphabetic principles, onset/rime, decoding, vocabulary instruction
Coyne et al. (2018)	1st, 2nd and 3rd grades general education	HI	Tier 2	Explicit instruction	General PA skills, letter sounds, alphabetic principle, decoding, comprehension instruction, oral reading, reading connected text
Dussling (2020)	1st grade MLs and at risk	RI	Tier 2	Explicit instruction, support is gradually removed, word and sentence dictation, visual supports/pictures, verbal cues/prompts, corrective feedback	Recognition and manipulation of phonemes, general PA skills, letter sounds, alphabetic principle, decoding, encoding, common orthographic patterns, oral reading, reading connected text, reading HFW
Fien et al. (2015)	267 1st grade at risk; 32 were MLs and 14 SWD	TI and Para	Tier 1 and Tier 2	Explicit instruction, hand signals, finger tapping, word and sentence dictation, verbal cues/prompts, corrective feedback	Blending, segmenting, general PA skills, letter sounds, alphabetic principle, decoding, encoding, common orthographic patterns, morphology, oral reading, repeated reading, reading

					connected text, reading HFW
Flynn et al. (2023)	23 1st grade all at risk; 2 SWD	RI	Tier 3	Explicit instruction, hand signals, finger tapping	Recognition and manipulation of phonemes, segmenting, general PA skills, letter sounds, decoding, encoding, short vowel sounds
Frates et al. (2024)	2 1 K and 1 1st grade; Both MLs and SWD	RI and TI	Tier 2	Explicit instruction, word boxes, visual supports/pictures	Segmenting, letter sounds, comprehension, shared reading
Fuchs et al. (2021)	491 1st grade; 59 MLs; 34 SWD; 221 at risk	RI and TI	Tier 1	Explicit instruction, teacher read aloud w/ students following along, corrective feedback	Recognition and manipulation of phonemes, blending, segmenting, letter sounds, decoding, timed word reading, oral reading, repeated reading, reading connected text, reading HFW
Gillon et al. (2019)	K MLs	TI	Tier 1	Teacher read aloud w/ students following along	Recognition and manipulation of phonemes, blending, segmenting, general PA skills, letter sounds, vocabulary instruction, story reading for oral language, comprehension instruction, writing instruction
Gonzalez-Frey and Ehri (2021)	K general education	RI and TI	Tier 3	Explicit instruction, visual supports/pictures, verbal cues/prompts, corrective feedback	Blending, segmenting, letter sounds, decoding
Helf et al. (2014)	K at risk	TI, Para, and HI	Tier 2	Explicit instruction, verbal cues/prompts, corrective feedback	Blending, segmenting, general PA skills, letter sounds, onset/rime, decoding, encoding, long vowel sounds, common orthographic patterns, short vowel sounds, oral reading,

					reading connected text, reading HFW
Hodgins and Harrison (2021)	K, all at risk	TI	Tier 2	Explicit instruction, finger tapping, word boxes	Recognition and manipulation of phonemes, blending, segmenting, general PA skills, letter sounds, onset/rime, decoding, vocabulary instruction, oral reading, reading connected text
Joseph (2018)	3 2nd grade; all SWD and considered at risk	RI and TI	Tier 3	Explicit instruction, word boxes, verbal cues/prompts	Recognition and manipulation of phonemes, segmenting, general PA skills, letter sounds, alphabetic principle, decoding, encoding
Kuppen and Bourke (2017)	K (general education)	TI	Tier 1	Hand signals, visual supports/pictures, teacher read aloud w/ students following along	Recognition and manipulation of phonemes, rhyming, segmenting, letter sounds
McBreen and Savage (2022)	25 3rd grade (general education)	RI	Tier 2	Explicit instruction, motivational strategies	Letter sounds, decoding, common orthographic patterns, comprehension instruction, shared reading
Messer and Nash (2018)	2nd at risk	Tech and Para	Tier 3	Motivation strategies, visual supports/pictures, verbal cues/prompts, corrective feedback	Blending, segmenting, letter sounds, decoding, oral reading
Metasala and Kalindi (2022)	K, MLs	Tech and TI	Tier 3	Explicit instruction, support is gradually removed, motivation strategies, visual supports/pictures, verbal cues/prompts	Recognition and manipulation of phonemes, rhyming, blending, segmenting, general PA skills, letter sounds, alphabetic principle, decoding, vocabulary instruction, comprehension instruction, oral reading, reading connected text, reading HFW

Miles et al. (2022)	1st grade SWD, MLs, and at risk	TI and HI	Tier 2 and 3	Explicit instruction, verbal cues/prompts	Letter sounds, decoding, common orthographic patterns, story reading for oral language, comprehension instruction, oral reading, reading connected text, reading HFW, choral reading
Nicholson et al. (2019)	K-4th grade (5 yr 6 months to 10 yr 5 months) (general education)	TI, Para, and HI	Tier 3	Explicit instruction	Syllable segmentation, blending, letter sounds, alphabetic principle, decoding, encoding, long vowel sounds, common orthographic patterns, short vowel sounds, oral reading, reading connected text, reading HFW
O'Callaghan et al. (2016)	K MLs	Tech	Tier 3	Explicit instruction, verbal cues/prompts, corrective feedback	Rhyming, blending, segmenting, general PA skills, letter sounds, encoding, long vowel sounds, common orthographic patterns, short vowel sounds, vocabulary instruction, comprehension instruction, timed word reading, reading connected text, reading HFW
Olszewski et al. (2018)	1 3rd grade SWD	RI	Tier 3	Explicit instruction, teacher read aloud w/ students following along	Recognition and manipulation of phonemes, blending, deletion, segmenting, general PA skills, letter sounds, decoding, comprehension instruction, oral reading, reading connected text, story maps

Partanen et al. (2019)	3rd grade at risk	Tech and TI	Tier 3	Explicit instruction, graphic organizer	Blending, letter sounds, decoding, common orthographic patterns, vocabulary instruction, repeated reading, reading HFW, shared writing
Prahl et al. (2022)	3 2 1st grade and 1 3rd grade; all SWD	RI	Tier 2	Explicit instruction, repeated lessons	Recognition and manipulation of phonemes, initial sounds ID, blending, segmenting, general PA skills, letter sounds
Rahn et al. (2015)	K and 1st grade; MLs and SWD	RI	Tier 3	Explicit instruction, corrective feedback	Recognition and manipulation of phonemes, letter sounds
Ritter et al. (2021)	K	RI	Tier 2	Explicit instruction, motivational strategies, corrective feedback	General PA skills, letter sounds, alphabetic principle, decoding
Shamir et al. (2018)	Kand 1st grade general education	Tech	Tier 3	Explicit instruction, repeated lessons, word/sound sorts, visual supports/pictures, verbal cues/prompts, corrective feedback	Recognition and manipulation of phonemes, initial sounds ID, rhyming, blending, general PA skills, letter sounds, alphabetic principle, decoding, encoding, common orthographic patterns, vocabulary instruction, comprehension instruction, oral reading, reading connected text, reading HFW, writing instruction, writing simple sentences
Solari et al. (2018)	1st grade at risk	TI	Tier 2	Explicit instruction, word boxes, repeated lessons, verbal cues/prompts, corrective feedback	Blending, segmenting, letter sounds, decoding, encoding, common orthographic patterns, comprehension instruction, oral reading, reading connected text, reading HFW

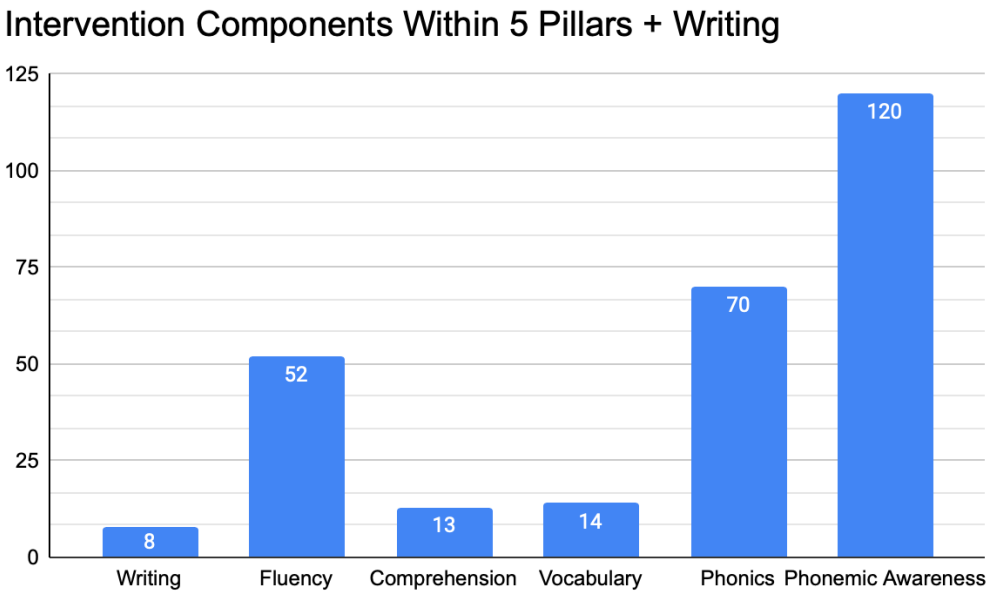
Vollebregt et al. (2021)	1st grade SWD	RI and TI	Tier 1	Explicit instruction, verbal supports/pictures, verbal cues/prompts	Recognition and manipulation of phonemes, alphabetic principle, common orthographic patterns, short vowel sounds, vocabulary instruction, comprehension instruction, timed word reading, choral reading, writing instruction
Wheldall et al. (2016)	K general education	TI	Tier 1	Explicit instruction, teacher read aloud w/ students following along	General PA skills, story reading for oral language
Winn et al. (2020)	K-3rd grade all at risk	Tech and TI	Tier 3	Support is gradually removed, verbal cues/prompts, corrective feedback	Blending, segmenting, letter sounds, alphabetic principle, decoding, reading HFW
Wise et al. (2016)	1st grade; at risk and MLs	TI	Tier 2	Explicit instruction	Recognition and manipulation of phonemes, syllable segmenting, blending, segmenting, general PA skills, letter sounds, alphabetic principle
Zoski and Erickson (2017)	K; at risk, MLs, SWD	RI	Tier 2	Explicit instruction, word/sound sorts, visual supports/pictures	Blending, segmenting, general PA skills, letter sounds, morphology, shared reading

HFW= high frequency words; HI= hired implementor; ID= identification; MLs= multilingual learners, PA=phonemic awareness; Para= paraprofessional implemented; QED=quasi-experimental design; RCT=randomized controlled trial; RDD=regression discontinuity design; RI= researcher implemented; SCD=single case design; SWD= student with disabilities; Tech= technology implemented, TI= teacher implemented

In addition to identifying the individual components of each intervention, the components were analyzed and coded within the five pillars of reading or if a writing component was included. Figure 2 offers a visual for the number and types of components found in the 35 reviewed studies. It is not surprising that PA (which included some elements of phonological awareness such as rhyming), phonics, and fluency had the most components as many of the studies were focused on code-based instruction. Some studies included multi-component interventions with both code-based and knowledge-based instructional elements. For the studies that included writing, three of them involved writing fluency activities such as letter formation (e.g., transcription) or print conventions and writing simple sentences. The

remaining writing components used meaning-based instruction with shared writing, story maps, or general writing instruction for ideas and content.

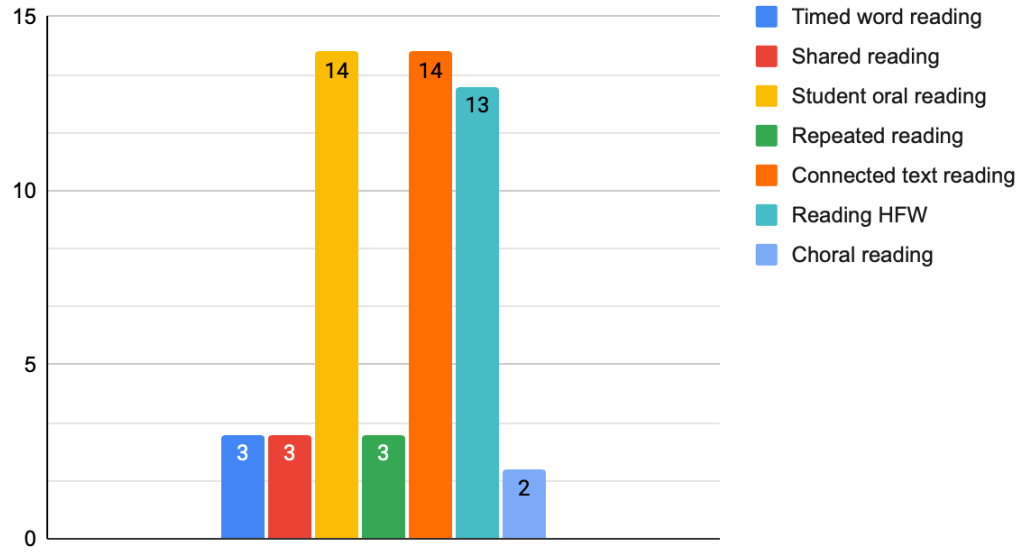
Figure 2 Intervention Components Within the Five Pillars Plus Writing



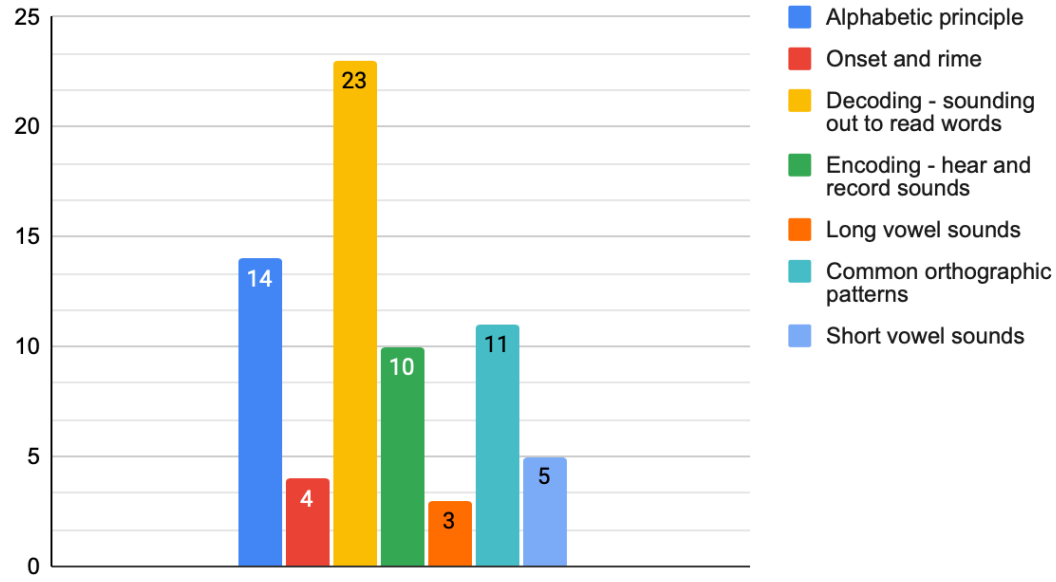
The three code-based pillars had individual components occur the most across the interventions. Within the categories of fluency, phonics, and PA, the skills of blending sounds, segmenting sounds, and the inclusion of letters to practice letter-sound correspondence to give students the opportunities to practice decoding through oral reading of connected text were among the most common components. Figure 3 offers a compilation of the most used components in the fluency, phonics, and PA pillars.

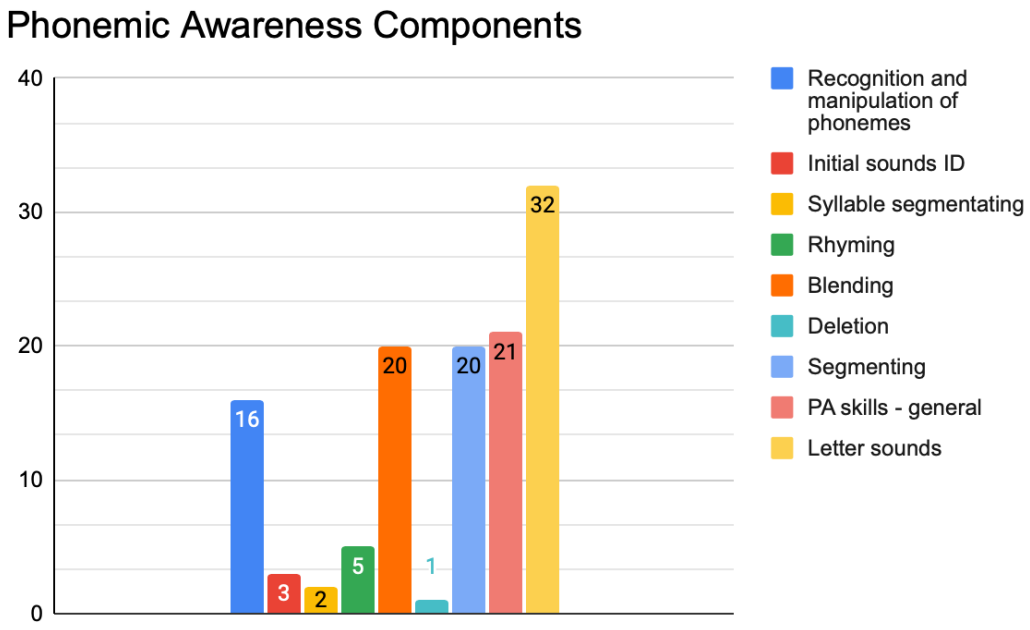
Figure 3 Fluency, Phonics, and PA Components

Fluency Components



Phonics Components





Dependent Variables and Effects

The second research question sought to identify the instructional elements of phonological awareness and PA that have been found to be effective in reading outcomes for K-3 students:

> *Research Question 2:* What does the research say about the effectiveness of phonological awareness or PA instruction in improving foundational reading outcomes for readers in grades K-3?

The 35 reviewed studies found outcomes related to the following skills: phonological awareness including rhyme production and detection; PA; blending; segmenting; elision/deletion; substitution; initial sound segmentation; letter-sound fluency; and decoding. Further, some studies reported more than one outcome related to phonological awareness, PA, or decoding. For example, a study may include a composite outcome for PA and also outcomes for phoneme blending, segmenting, and deletion.

Phonological awareness outcomes

Seven studies had positive effect sizes for phonological awareness outcomes. Five of these seven studies included multi-component instruction with both code-based and knowledge-based instructional techniques. For example, in a tier 1 setting with general education K students, Gillon et al. (2019) used Better Start Literacy Intervention that included teacher read alouds with students following along as an instructional technique and PA skills (e.g., blending, segmenting), vocabulary instruction, story reading to build oral language, comprehension instruction, and writing instruction. They found a medium effect size for PA (d = .60) but did not find a significant outcome for letter sound knowledge. Another study implemented in a tier 1 setting, Vollebregt et al. (2021) found a large effect (η_p^2 = .24) for PA for a first grade sample

that included SWD. Vollebregt et al. (2021) used Reading for All for their tested intervention which included PA, phonics, vocabulary, comprehension, oral reading fluency, and writing instruction. Also using a mix of code-based and knowledge-based instruction, Cassady et al. (2018) implemented Imagine Learning as an individually-delivered (tier 3) technology-based intervention for K and first grade students and the sample included MLs and SWD. They found a small effect for PA (η_p^2 =.018). Zoski and Erickson (2017) used code-based and knowledge-based instruction, specifically for morphology, for K students with some identified as at risk for reading difficulties, SWD, or MLs in a tier 2 small group setting. While they did not find significant differences across groups, they found within group effect sizes ranged from moderate to very large (d=.57-3.96). They found that letter knowledge, PA, and morphological knowledge all had positive outcomes on PA. Hodgins and Harrison (2021) implemented the Talking Tables intervention in a tier 2 small group setting taught by teachers to K students identified as at risk. Talking Tables used explicit instruction with finger tapping and word boxes to teach blending, segmenting, phoneme manipulation, letter sounds, decoding, oral reading skills, and vocabulary. They found the intervention had a strong effect for PA (d = .77).

The remaining two studies only implemented code-based intervention elements and both had small to large effect sizes. Messer and Nash (2018) used a computer-assisted reading intervention called Trainer Text to teach blending, segmenting, letter sounds, decoding, and oral reading to second grade students identified at risk of reading difficulties. They found a strong effect on PA outcomes (*d* = 1.34) and phonological short-term memory (*d* = .90). Kuppen and Bourke (2017) examined a PA program using singing and spoken words in a tier 1 setting with K students. Teachers used hand signals, visual supports, and reading or singing aloud with students following along with the text to teach rhyming, segmenting, and letter sounds. They found the spoken program had the strongest effects: rhyme detection (d = .50), rhyme production (*d* = .85), and phoneme deletion (*d* = .24).

Taken together, five of the seven studies used both code-based and knowledge-based components; six had students in K or first grade; and three were taught in tier 1 settings. Because the English language is "morphophonemic" (Moats & Tolman, 2019, p. 13) in that it is both sound-based and meaning-based, it is not surprising that interventions that included both code- and meaning-based components had positive outcomes on PA as students can use both systems to support their learning. Two common patterns exist in these seven studies: a) all of them included visual or verbal supports, explicit instruction, or some form of teacher modeling; and b) they all used letter sounds or the alphabetic principle within the intervention. These findings align with the evidence from Foorman et al. (2016) in the WWC practice guide which suggest using letter-sound activities to build letter-sound knowledge can help students become more aware of the individual phonemes. While these outcomes involved PA skills, the addition of letters and words may have been a contributor of students' abilities to rhyme or segment at the word or phoneme level.

Phonemic awareness outcomes (composite)

Five studies identified positive outcomes for composite measurements of PA skills. Most of these studies had medium to large effect sizes and one used a single-case design (SCD) with one third grade SWD and had positive effects for the PA composite measure. Three of the five studies used code-based instruction and two used both code-based and knowledge-based

instructional approaches. During a three-week summer reading program for general education students, Nicholson et al. (2019) implemented a phonics-based intervention for K through fourth grade students in a one-on-one setting for more than 180 minutes each week. They found the intervention had a large effect size for PA (*d* = 1.49). The inclusion of both PA skills (e.g., blending) and phonics skills (e.g., letter sounds, decoding, encoding) and practice reading connected text to apply those skills may have been one factor in the strong outcome. Further, this intervention involved an intensive tier 3 setting (e.g., individual instruction and increased dosage) which could lead to greater outcomes for some students. In tier 1 general education K classrooms, Wheldall et al. (2016) used the PreLit intervention to teach PA skills and story reading to build oral language and found a medium effect size for PA (*d* = .59). Similar to Wheldall et al., Olszewski et al. (2018) also implemented a code-based and knowledge-based intervention with one third grade SWD and found positive outcomes for the overall PA measure. Winn et al. (2020) and Fuchs et al. (2021) both used code-based interventions for at-risk students between 90 and 180 minutes per week and found medium effects for PA. Winn et al. implemented Reading Doctor (RD) for K through third grade students on individual computers and found a medium effect (*d* = .43), and Fuchs et al. found that the phonological awareness literacy screening (PALS) group that did not add a fluency component had stronger outcomes (*g* = .59) than the group with the added fluency element. The outcomes for PA composite measures indicate that technology, individual instruction, and targeted instruction on PA skills using mostly code-based instruction are effective intervention components.

Blending

Eight studies found PA instruction had positive effects on blending with all of them using tier 2 or tier 3 interventions. Four of them used technology indicating that computer-assisted programs are effective in teaching blending skills. Shamir et al. (2018) investigated the effects of the Waterford Early Reading Program, a computer-based program that teaches both code-based and knowledge-based skills. The study included K and first grade students in a general education setting with 90 to 180 minutes each week of instruction; it found no significant outcomes for the K students but a large effect on blending (*d* = .85) for first grade students. Also incorporating technology, Metasala and Kalindi (2022) used the Ooka Island reading program for MLs in K and found medium effects (study 1: *d* = .79 and study 2: η_p^2 = .065). Anthony (2020) used Earobics Step 1, computer-assisted instruction, in K classes and found moderate outcomes for students considered poor readers (ES = .71). O'Callaghan et al. (2016) studied the Lexia Core5 program, which can be used on computers or iPads, among K students and found a small effect size for blending (*d* = .36).

Three studies implemented small group instruction provided by teachers or researchers and found medium effects for blending skills. Hodgins and Harrison (2021) used the Talking Tables intervention for at-risk K students for 90 minutes or less each week and found a moderate effect for blending (*d* = .42). McBreen and Savage (2022) used explicit instruction and motivational strategies to implement a code-based and knowledge-based intervention for general education third grade classes and found a moderate outcome for blending (*d* = .62). In a sample of first grade students who were MLs and at risk, Dussling (2020) found a multimodal code-based intervention was effective for teaching blending skills (*r* = .50). In a tier

3 setting with one SWD, Olszewski et al. (2018) found explicit instruction of a code-based and knowledge-based intervention had positive outcomes for blending skills.

The interventions that were the most effective for teaching blending involved either technology or a small group and most of the studies included K or first grade students. All of them included explicit instruction and the majority of them incorporated both code-based and knowledge-based components.

Segmenting

Eleven studies had positive outcomes for segmenting skills with all of them using tier 2 or tier 3 instructional settings. Only one of the studies involved technology, five of them used code-based instruction only, and all of them had weekly dosages of 180 minutes or less. O'Callaghan et al. (2016) found a small effect on segmenting (*d* = .23) for the Lexia Core5 program. Four studies implemented individual instruction from a researcher, teacher, or hired interventionist. Two of these studies used code-based only instruction and found large effects on segmenting: Joseph (2018) used word boxes to teach PA skills and found all three second grade SWD had large effect sizes (ES = 35.9, 20.3, and 87.9); Flynn et al. (2023) used the Crack the Code intervention for first grade students at risk SWD and found it to be highly effective (*ES* = .81). For first grade students who were taught both in small groups and individually with the Reading Rescue program, both code-based and knowledge-based, Miles et al. (2022) found that the second cohort did not have significant outcomes on segmenting but the first cohort had a small effect. Those in a small group performed better on segmenting compared to the control (*d* = .44) and those who received individual instruction *(d* = .32).

Seven of the eleven studies were delivered in small groups and only one of them (McBreen & Savage, 2022) found a large effect for segmenting, the remaining six had small effects. McBreen and Savage (2022) used explicit instruction and motivational strategies in third grade general education classrooms to teach letter sounds, phonics patterns, comprehension, and shared reading and found a large effect size (*d* = 1.76) for segmenting. Out of the other six, half of them used code-based instruction only. Dussling (2020) found small effects for segmenting (*r* = .42) when implementing the Road to Reading intervention for at-risk first grade MLs; using the Early Reading Tutor for at-risk K students, Helf et al. (2014) found small effects (η_2= .01); and Ritter et al. (2021) found positive outcomes for phoneme segmentation for K students using K-PALS. The following studies incorporated both code-based and knowledge-based interventions: Frates et al. (2024) found positive outcomes on segmenting for two MLs with disabilities, one in kindergarten K and one in first grade; using Reading RULES for at-risk first grade students, Solari et al. (2018) found a small effect for segmenting (g=.19); and Coyne et al. (2018) found a small effect size (*ES* = .39) for first, second and third grade students when implementing the Proactive Early Interventions in Reading program.

Elision/deletion, substitution, initial sound segmentation

Six studies had positive effects for either elision/deletion, substitution, or initial sound segmentation. Only one of them had an outcome for phoneme substitution, Shamir et al. (2018) used a technology reading program for K and first grade students and found a large effect for substitution for the first grade group only (*d* = .97). Prahl et al. (2022) had one first

grade and one third grade participant, both SWD, and found a positive outcome for one participant on initial sound segmentation but did not find a significant outcome for the other participant when using the Intensive Phonological Awareness (IPA) program.

For the studies with deletion or elision outcomes, the one with the largest effect used code-based instruction only. Wise et al. (2016) used tier 2 instruction for at-risk first grade MLs and found a large effect size for elision (*d* = 1.51). Shamir et al. (2018) found no significant differences for phoneme deletion for the K group, however, they found a medium effect (*d* = .68) for the first grade group. For one third grade participant, Olszewski et al. (2018) found positive outcomes for phoneme deletion skills. In Hodgins and Harrison's (2021) study, the Talking Tables intervention was found to produce medium effects for elision (*d* = .43). Kuppen and Bourke (2017) found a small effect for deletion in the spoken program (cohort 1: *d* = .24; cohort 2: *d* = .02), which was delivered in a tier 1 setting and explicit instruction was not provided although the program did include hand signals, visual supports, and the teacher reading aloud with students following along.

The outcomes in this section indicate that tier 2 and tier 3 settings may be more effective in teaching the more advanced PA skills of deletion and substitution. Further, interventions delivered through technology are also an effective method of teaching PA skills.

Letter-sound fluency

Letter-sound fluency includes outcomes for correct letter sounds, letter-sound identification, or phoneme-grapheme matching. This outcome differs from decoding as it is at the letter or grapheme level, not blending sounds to read at the word level. Six studies had positive outcomes for letter-sound fluency. Hodgins and Harrison (2021) found the Talking Tables intervention had a large effect size (*d* = 1.04) on letter sound fluency for at-risk K students. Shamir et al. (2018) and Dussling (2020) found medium effects from their interventions. Shamir et al. found the Waterford Early Reading program was effective for the K group (*d* = .51 on letter to sound linking). Dussling found the Road to Reading intervention was effective for at-risk MLs in first grade (*r* = .56). Interventions that implemented individual instruction with SWD found positive outcomes when researchers implemented explicit instruction, corrective feedback, and visual or verbal supports to teach phonemes and letter sounds. Rahn et al. (2015) found significant outcomes for one of the two participants for letter sounds; Chai et al. (2015) found the Touch Sound iPad application was effective in teaching letter sound identification; and Frates et al. (2024) had positive outcomes on letter sound fluency.

Decoding

Twelve studies had positive effect sizes for decoding skills with three having large effect sizes, four having medium effect sizes, and five having small effect sizes. All 12 studies used explicit instruction as an instructional technique and taught PA skills and letter sounds. Five studies had student participants in K, six had first grade participants, three had third grade students, and only one included second grade students. The three studies with the large effect sizes used tier 3 instruction and taught the least amount of instructional components within the intervention. With two first grade students and one third grade student, Coleman et al. (2021) implemented PA lessons using PowerPoint slides as a scaffold with visual supports/pictures,

verbal cues/prompt, and repeated lessons to teach blending, letter sounds, onset/rime, and decoding skills. They found moderate to large effect sizes for decoding (Tau-U =.484-.905). In a study with K participants, Gonzalez-Frey and Ehri (2021) found that using connected phonation (e.g. sssiiitt=sit) to teach students to blend the phonemes in consonant-vowel-consonant words with stop consonants was more effective than using segmented phonation (e.g. s-i-t=sit) over three studies (1: *d* = 2.60; 2: *d* = 2.60; 3: *d* = 1.32). Their intervention used only four instructional components: blending, segmenting, letter sounds, and decoding. The third study with a large effect size for decoding used the Crack the Code program for first grade participants. Flynn et al. (2023) incorporated both PA and phonics skills and found large effect sizes for decoding (*ES* = .73 for nonsense words; *ES* = .86 for real words). The findings of these three studies align with the results from Ehri et al. (2001) that found one to two PA skills taught at a time was more effective than teaching three or more at the same time.

Of the four studies with medium effect sizes for decoding, one of them used technology as the implementer (e.g., Ooka Island), two of them delivered instruction in small groups, and one provided instruction in a tier 1 whole class setting. All four of them were administered to K or first grade students. Only one of them used only code-based instructional practices with the remaining three using both code-based and knowledge-based instructional components. Dussling (2020) used the Road to Reading program for first grade students in a small group which included only code-based instruction such as PA skills, letter sounds, alphabetic principle, decoding, encoding, reading connected text, and reading high frequency words. The first grade student sample included MLs and students identified as at risk for reading difficulties. Dussling found medium effects for decoding (*r* = .48). Using Ooka Island, a computer-based reading program, for K MLs, Metasala and Kalindi (2022) found medium effects for decoding (study 1: *d* = .48 and study 2: η_p^2 =.057). The Ooka Island program includes both code-based instruction and knowledge-based instruction (e.g., vocabulary and comprehension). Chapman (2016) explored the Quick60 Foundation program for K students in a tier 1 setting which included both PA skills and encoding skills (code-based) and comprehension instruction (knowledge-based). Chapman found medium effects for decoding of nonsense words (*d* = .63 for the older cohort and *d* = .79 for the younger cohort). Using small group instruction to provide the Reading RULES intervention to first grade students, Solari et al. (2018) found a medium effect for decoding (*g* =. 60).

Five studies had small effect sizes for decoding with three of them using technology as the implementer. Shamir et al. (2018) used the Waterford Early Reading Program to deliver individual computer-based instruction to K and first grade participants and found no significant effects for K students but found a small effect on blending words for first grade (*d* = .37). The program used explicit instruction, visual and verbal supports, and corrective feedback to teach code-based skills such as rhyming and blending and knowledge-based skills such as vocabulary knowledge and comprehension instruction. O'Callaghan et al. (2016) also investigated the effects of a technology-based program, Lexia Core5, which was provided to K students. Lexia Core5 uses explicit instruction, visual and verbal supports, and corrective feedback to teach skills within all five pillars of reading. They found a small effect size for decoding (*d* = .35). Partanen et al. (2019) implemented an intensive tier 3 intervention with a variety of programs including Explode the Code, LexiaCore 5, Read Naturally and several others in tandem with direct teacher instruction. They did not find significant outcomes for PA but they did find a small effect size for decoding fluency (*d* = .18). For a sample of first, second,

and third grade students, Coyne et al. (2018) examined the Proactive Early Interventions in Reading intervention in small groups and found a small effect for decoding (*ES* = .36). Fien et al. (2015) used both whole group and small group instruction to teach mostly code-based instruction to first grade students and did not find a significant outcome for correct letter sounds but did find a small effect for decoding (*g*= .42).

All 12 studies that had positive outcomes for decoding incorporated both PA instruction and letters or graphemes within the intervention. Only two studies were implemented in whole-group settings (tier 1) with more than half of them using teacher- or researcher-implemented instruction or technology to deliver individual instruction (tier 3). The next section presents results of effective interventions for subgroups and identifies specific elements of the interventions (e.g., dosage, instructional techniques, setting, etc.) associated with positive outcomes.

Subgroup analysis: what interventions are effective for MLs, SWD, Students at-risk, Students in Gen Ed, Interventions conducted in Tier 1/2/3

The third research question aimed at the identification of specific features that correlated with improved phonological awareness and PA outcomes:

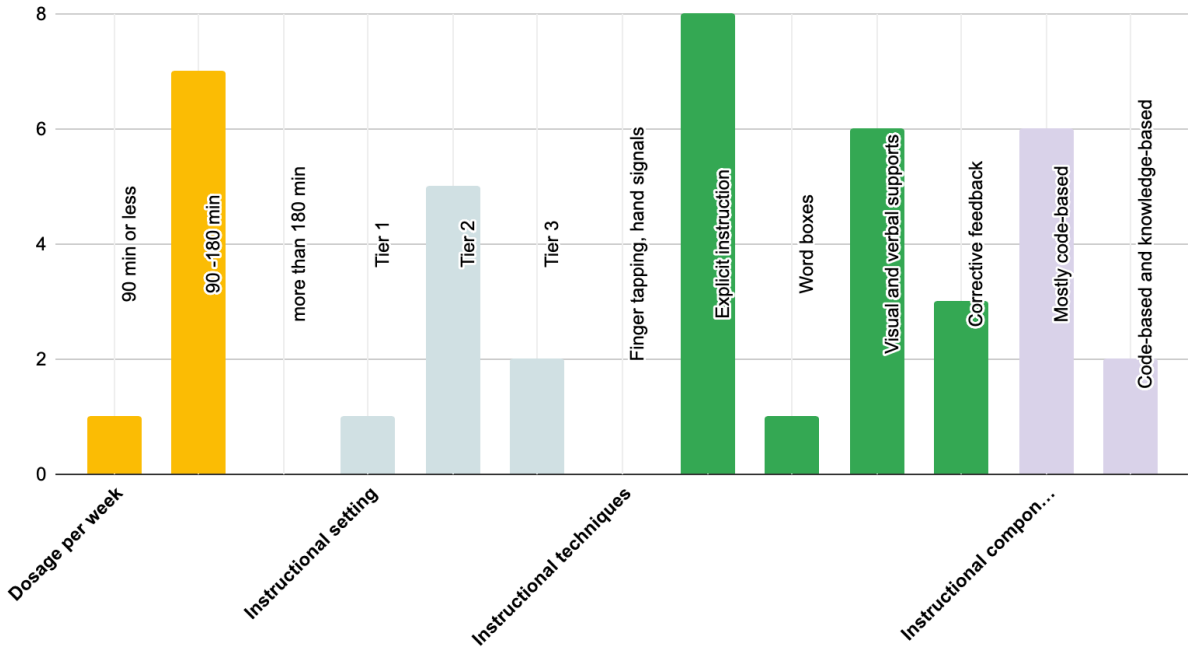
> *Research Question 3:* What features of instructional interventions (e.g., type of instruction, duration, grade level) are associated with improved outcomes? Do these features differ according to student characteristics?

To answer this question, the sections below include intervention features that were effective for MLs, SWD, students at risk of reading difficulties, and students in general education. Within each of the subgroups, the intervention tiers (1, 2, and 3) are discussed.

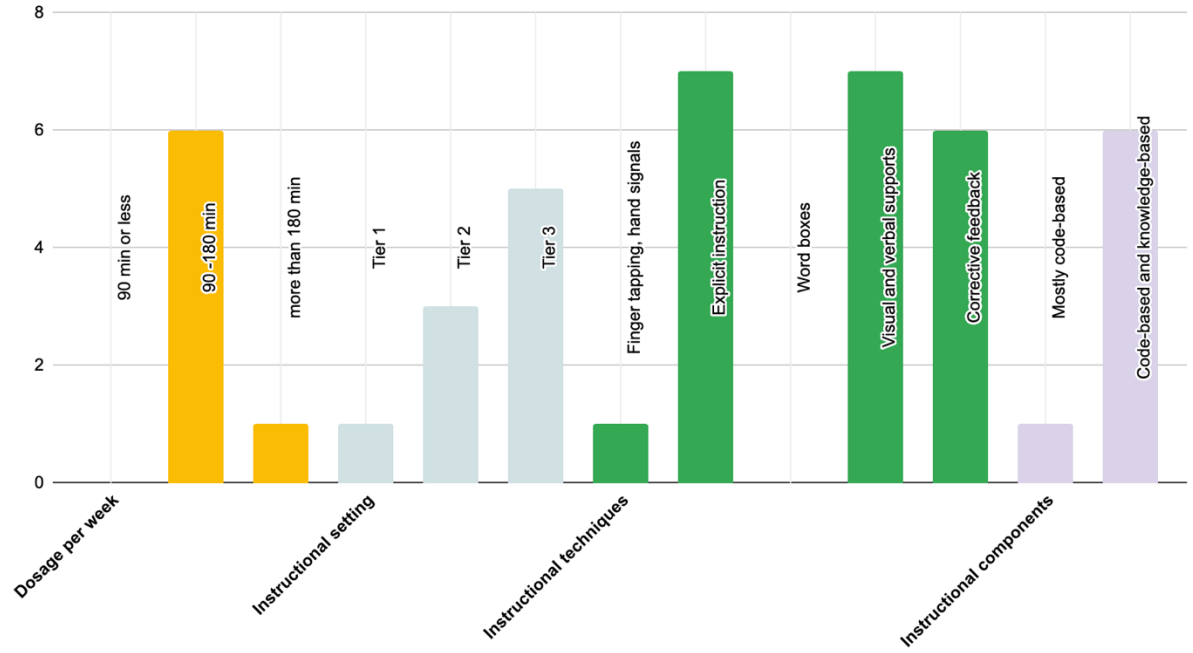
Multilingual learners (MLs)

For students learning English, interventions that used mostly code-based instruction, small groups, and explicit instruction with visual and verbal supports had the largest effect sizes for early literacy skills. Interventions that were provided for 20-30 minutes each day for no more than 180 minutes per week were found to be the most effective for MLs. Most notably, code-based instruction seems to be more effective for MLs as it allows them to learn and apply targeted sound-based, letter and word reading skills while not being overwhelmed with adding an additional cognitive load of comprehending text. The lack of finger tapping, hand signals, and word boxes in the interventions are surprising as those may be effective practices for MLs, future research on these practices may be useful to identifying their effectiveness. The interventions did include a large number of visual and verbal supports (e.g., prompts, cues, pictures, etc.) which were found to be effective in teaching PA skills to MLs. Figure 4 presents the intervention components compared to the effect sizes for MLs.

Moderate to large effects for ELs / MLLs



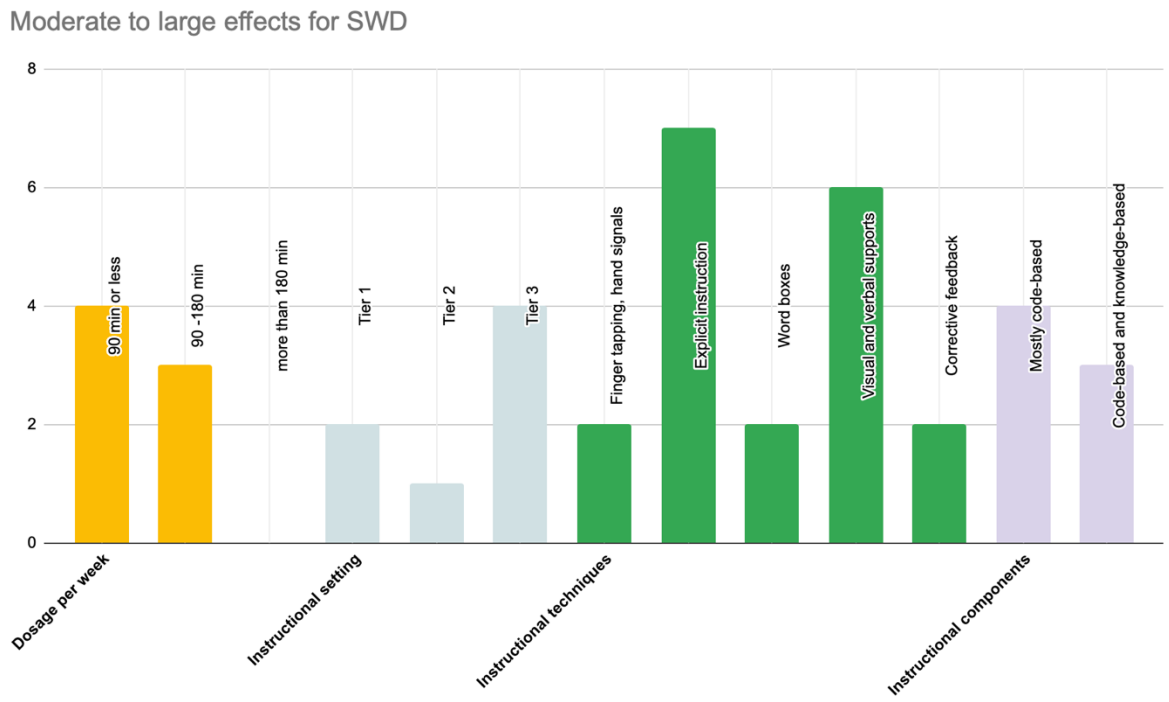
Small effects for ELs / MLLs

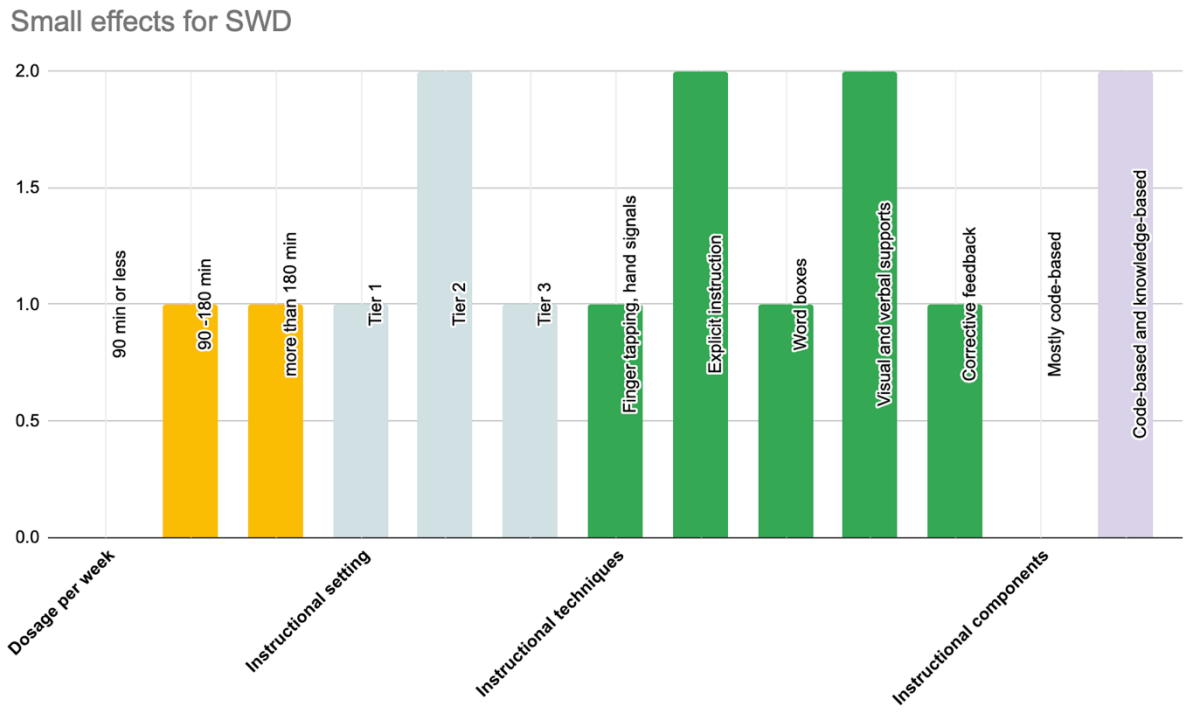


Students with disabilities (SWD)

For SWD, the intervention dosages that were more effective were less than 180 minutes per week, and targeted interventions with only or mostly code-based instruction was more effective than including knowledge-based instruction on early literacy outcomes such as decoding, segmenting, and other PA skills. Individual instruction was associated with larger effects for SWD disabilities than tier 1 or tier 2 settings. Similar to the findings for effective instruction for EL, explicit instruction and visual and verbal supports were shown to be effective techniques for SWD. Another similarity across the two subgroups is the lack of finger tapping, hand signals, word boxes, and corrective feedback. There is evidence that these strategies are effective, but it is surprising that they were not used more frequently with EL and SWD as they were used much more often in interventions for students at risk. Figure 5 presents the intervention components compared to the effect sizes for SWD.

Figure 5 Effects for SWD

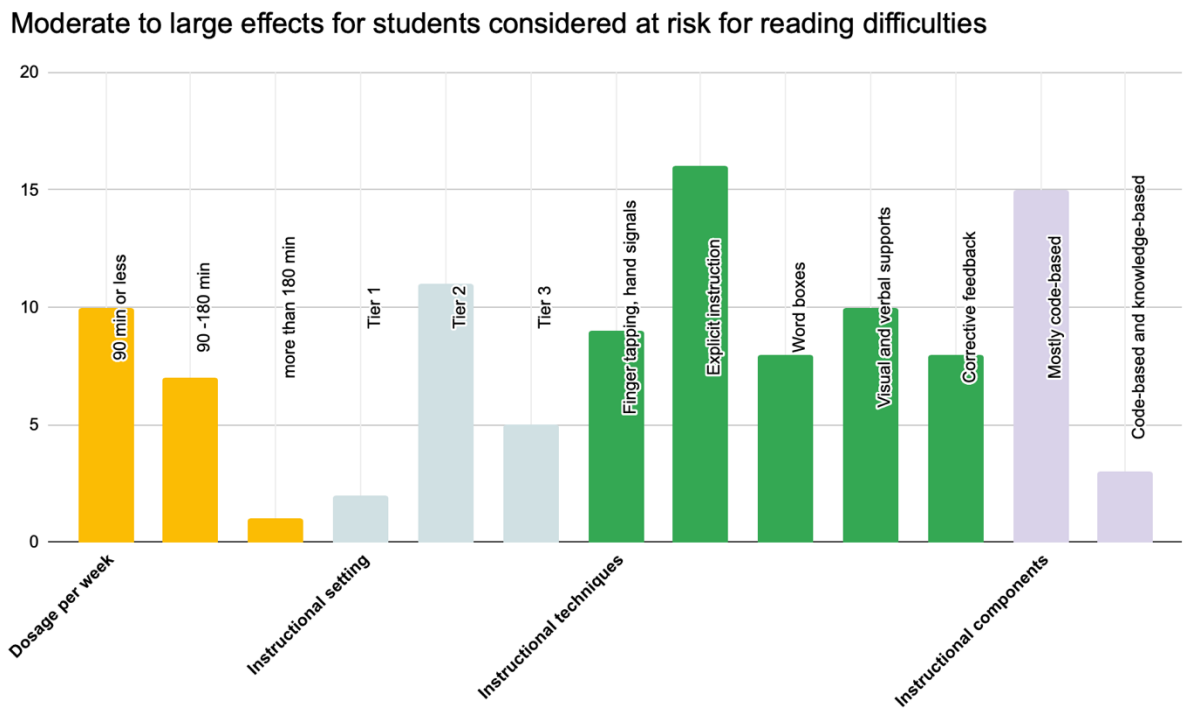


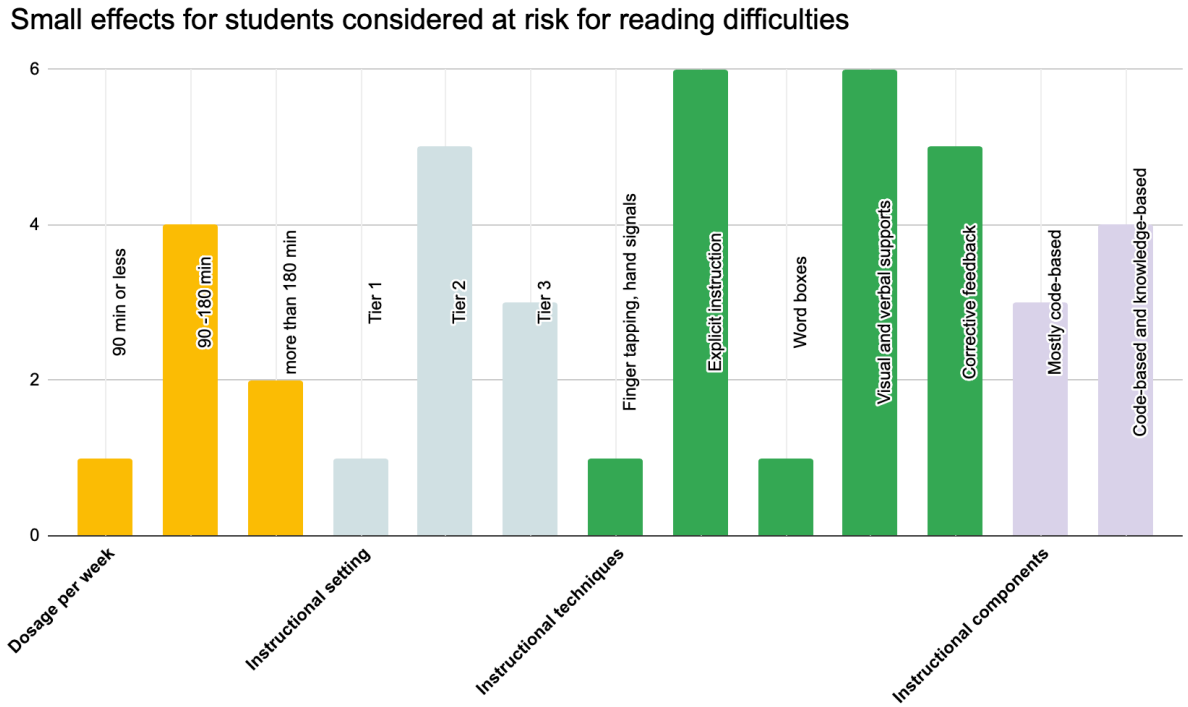


Students at risk

For students who were identified as at risk for reading difficulties, targeted and focused code-based interventions with explicit and multimodal instruction in small groups had the largest effects on blending, segmenting, decoding, and building letter-sound fluency. Using multimodal strategies such as hand signals, finger tapping or finger stretching the sounds, or word boxes to blend and segment sounds had greater outcomes than the interventions that did not include those practices. To address the barrier of limited instructional time, interventions with dosage of 90 minutes or less each week had the largest effect sizes. This finding is in line with the results from Ehri et al. (2001) which found the largest effect sizes for PA instruction lasted between 5 and 18 hours in total and suggested that regular sessions be limited to 30 minutes or less. For at-risk students, focusing on code-based instruction in the intervention resulted in the greatest outcomes, as opposed to including both code-based and knowledge-based skills. The inclusion of more skills and more time may be too intensive for at-risk students who may benefit from targeted instruction of PA and phonics skills and the opportunities to apply those skills with corrective feedback. When teachers or researchers implemented the intervention, the outcomes were greater than when it was provided by technology, paraprofessionals, or hired interventionists. Figure 6 presents the intervention components compared to the effect sizes for students identified as at risk for reading difficulties.

Figure 6 Effects for students considered at risk

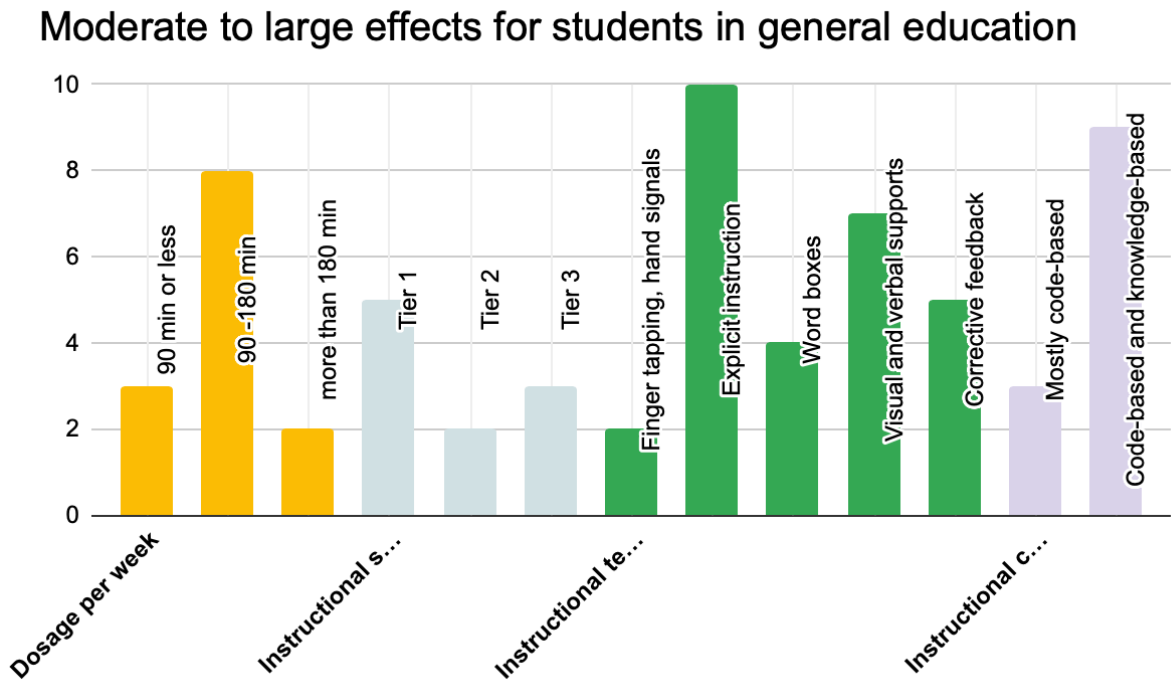




For all positive outcomes of interventions delivered to students at risk, the majority of the interventions included explicit instruction with visual and verbal supports and corrective feedback in small groups.

Students in general education

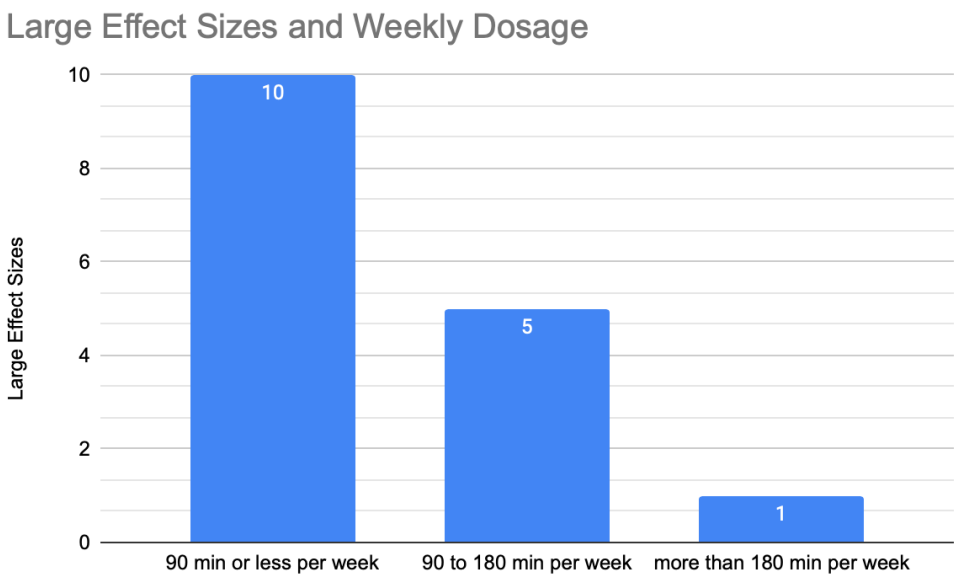
For studies that examined the effects of phonological awareness and PA instruction for students in general education settings, most of them were in tier 1 settings, used a combination of code-based and knowledge-based instruction, and were delivered between 90 and 180 minutes per week. In contrast to other subgroups, the combination of code-based and knowledge-based instruction had the greatest outcomes for students in general education. The combination instruction was delivered across whole-class, small group, and individual settings. One of the most effective interventions for teaching blending and substitution was the Waterford Early Reading program (Shamir et al., 2018) which was delivered in a tier 3 setting on individual computers. Figure 7 offers an overview of the intervention elements in studies with medium to large effect sizes.

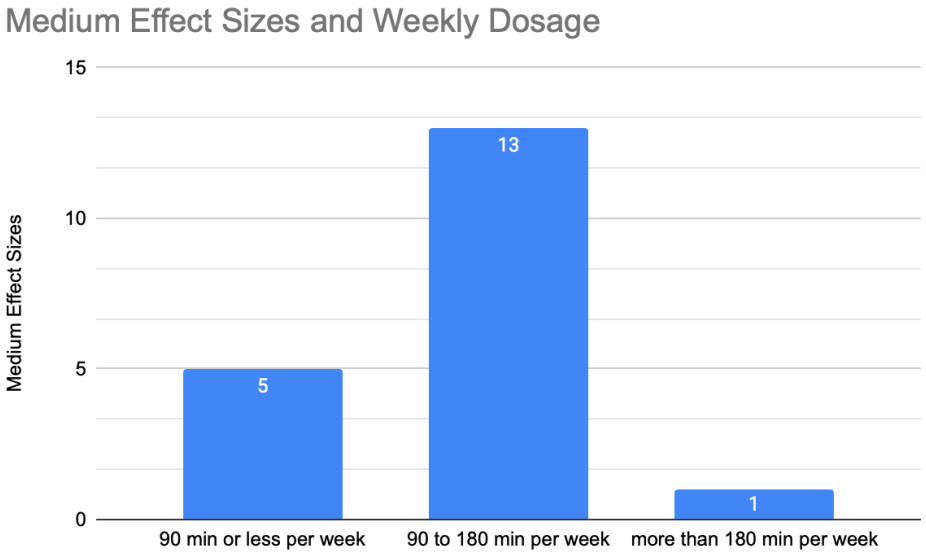


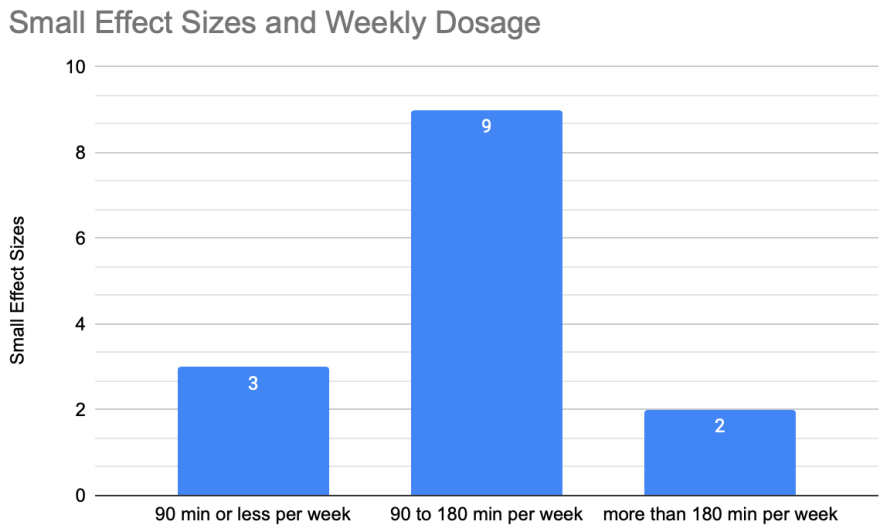
Effects of intervention dosage

Interventions that were implemented for 90 minutes or less weekly (or 15 to 20 minutes daily) had the largest effect sizes. Most intervention dosages within the reviewed 35 studies were less than 180 minutes weekly with only four studies exceeding 180 minutes. Of the four, the results suggest that increasing the instructional dosage does not lead to more effective outcomes.
Figure 7 outlines the effect sizes in relation to the weekly intervention dosage.

Figure 7 Effect sizes and weekly dosage


Large Effect Sizes and Weekly Dosage
Large Effect Sizes
10
8
6
4
2
0
10
5
1
90 min or less per week
90 to 180 min per week
more than 180 min per week


Medium Effect Sizes and Weekly Dosage
Medium Effect Sizes
15
10
5
0
5
13
1
90 min or less per week
90 to 180 min per week
more than 180 min per week



Discussion

Discussion of Overall Independent Variable Effectiveness

For K and first grade students, the most effective programs were delivered for 90 minutes or less per week (e.g., less than 20 minutes each day), were delivered in small groups or one-on-one by a teacher or researcher, and used hand signals, finger tapping or finger stretching, word boxes, or visual and verbal supports. Some of these programs included Crack the Code (Flynn et al., 2023), Talking Tables (Hodgins & Harrison, 2021), Sung and Spoken Program (Kuppen & Bourke, 2017), or an explicit and systematic intervention with visual and verbal supports (Gonzalez-Frey & Ehri, 2021; Zoski & Erickson, 2017).

Several technology programs demonstrated effectiveness in teaching phonological, phonemic, and decoding skills. The most effective programs included the Waterford Early Reading program (Shamir et al., 2018), Reading Doctor (Winn et al., 2020), teacher-created PowerPoint lessons (Coleman et al., 2021), Trainer Text (Messer & Nash, 2018), Ooka Island (Metasala & Kalindi, 2022), and Earobics (Anthony, 2020). Although Lexia Core5 (O'Callaghan et al., 2016) and Imagine Learning (Cassady et al., 2018) had positive outcomes on PA, blending, segmenting, and decoding, their effect sizes were small. The Ooka Island (Metasala & Kalindi, 2022) program was effective in teaching blending and decoding skills, but did not have significant outcomes for elision/deletion. The Waterford Early Reading program (Shamir et al., 2018) had more positive outcomes for the first grade group than for K. A possible reason the first grade group had stronger outcomes may be that the more advanced skills of phoneme deletion, substitution, blending phonemes, and blending words were acquired after having more time (e.g., a full year of K) to develop phonological awareness and PA skills. The K group had moderate outcomes for letter sound fluency indicating that teaching phoneme-grapheme correspondence with technology is an effective intervention.

Discussion of Components Effectiveness

Across the studies, the instructional techniques and components found to be the most effective included: explicit instruction, code-based instruction, dosages of less than 180 minutes each week, corrective feedback, visual and verbal supports (including hand signals, finger stretching, word boxes), and instruction delivered by researchers, teachers, or technology.

It is not surprising that explicit instruction was one of the components found in effective interventions. Ensuring that students have clear examples and models of specific skills helps them understand what it looks like and how to practice each specific skill. Further, corrective feedback, although a separate component, aligns with explicit instruction. Implementers need to ensure students know when they make a mistake and be given prompts to correct it or provided with the correct response. The focus on code-based instructional practices and allowing time to practice and apply related skills to support the ultimate goal of word recognition aligns with effective outcomes. This finding supports the results from Ehri et al. (2001) that found the instruction and focus on one or two PA skills at a time was more effective than teaching three or more skills. In other words, teaching fewer skills at a time may be more efficient and allow students to reach mastery more quickly. Further, teaching the sounds with the alphabetic code is more effective than only teaching PA skills. Using and manipulating phonemes is a step toward reading print, being able to blend, segment, and delete phonemes as discrete skills outside of print will not help students learn to decode words. Ehri et al. (2001) write, "…there is a danger that PA will be regarded as a magic bullet, will be taught blindly in isolation ad nauseam without any connection to reading and writing…" (p. 279). This also speaks to the findings of the smaller amounts of instructional time required to achieve positive effects. Again, less is more. Building in small amounts of targeted instruction to teach sound-based skills applied to graphemes on a regular basis can have highly-effective outcomes for word reading.

Using both a code-based and knowledge-based intervention was found to be effective for students in general education classes, but using a code-based only intervention was found to be effective for MLs, SWD, and students at risk of reading difficulties. For at risk students, greater amounts of multimodal supports (e.g., hand signals, finger stretching, etc.) were included in interventions shown to be the most effective.

Implications for Practice

The findings from this systematic review address the barriers discussed in the introduction: a) limited instruction due to lack of training and resources for teachers; b) limited instructional time; and c) ensuring student access to the appropriate intervention (e.g., tier 2, tier 3) with an appropriate implementer. When interventions were implemented by a trained researcher or teacher, the studies were found to be highly

effective for early literacy skills. Many resources and programs from this review were found to be effective in delivering high-quality instruction on phonological, phonemic, and code-based skills. It would be beneficial for schools and districts to ensure programs and resources are provided for teachers, interventionists, and parents/caregivers to use as well as provide ongoing training and development to support instructional delivery and to maximize instructional time.

A key finding from this review that also supports results from other research (Ehri et al., 2001) is that smaller dosages of targeted and focused instruction can be more effective than increased instructional time. Twenty- to thirty-minute daily interventions that incorporate sounds and letters are shown to be effective in teaching early literacy skills such as blending, segmenting, and decoding. These interventions do not have to be delivered in small groups, but could be integrated into tier 1 instruction provided to all students in the early grades within the daily core literacy block. Using assessment data to target the instructional needs can also support teachers and school staff in maximizing instructional time to ensure the early literacy skills are mastered for all students.

This review found explicit tier 1 instruction that combined both code-based and knowledge-based practices (e.g., PA and comprehension) was effective for students in general education settings indicating that comprehensive core grade-level instruction provided for all students within the daily literacy block was effective in developing their PA skills to support letter sound knowledge and decoding. For MLs, SWD and students identified as at-risk for reading difficulties, ensuring that instruction is explicit and provided in small groups or individually is shown to be highly effective to PA outcomes. For at risk students, smaller amounts of instruction with more multimodal supports such as word boxes, hand signals, and finger stretching, in small groups resulted in larger gains in early literacy skills.

Limitations

There were some limitations in this review. First, the inclusion of phonological awareness was intentional to capture studies that taught those skills in their interventions; however, most studies on phonological awareness in particular include Pre-K students which were excluded in this review. Although some of the dependent variables included phonological awareness, many of the interventions did not focus on phonological awareness but included PA skills instead.

Second, some studies were more explicit and thorough in their intervention descriptions and included all or most of the instructional techniques and components used; however, some studies did not provide as much detail making those intervention descriptions less robust and clear. When there was a lack of detail but the name of the program or intervention was provided, the researcher searched for it online to identify as many techniques and instructional components as possible. In some cases, the lack of detail may have impeded the accuracy of what was included in the interventions leading to

some instructional components or techniques being omitted for the causes of effectiveness.

Future Research

For the ML and SWD subgroups, the lack of finger tapping, hand signals, and word boxes in the interventions with moderate to large effects is surprising as those may be effective practices for students in those subgroups. Future research on these practices may be useful to identifying their effectiveness. In addition to specific instructional techniques, more tier 2 and 3 interventions were studied for MLs, at risk, and SWD. While these were found to be effective, future research should examine the impact of interventions for these subgroups of students in high-quality tier 1 instructional settings.

Further, this review did not include studies with students in Pre-K. Future research on both the specific interventions and the breadth of PA interventions for students prior to entering K would provide more insight into effective developmental trajectories which would support K-third grade teachers in implementing the most effective practices to maximize instructional time.

Conclusion

The findings from this review indicate that implementing effective PA interventions allow students to learn the foundational sound-based skills that support their ability to decode and encode. Strong effect sizes were found for tier 1 instruction that included both code-based PA and phonics instruction and knowledge-based vocabulary and comprehension instruction. This review also found that longer and more frequent instruction did not result in better outcomes but that shorter and consistent instructional dosages were more effective.

In addition to instruction dosage, this review also found that the implementer of the intervention can be a factor in the effectiveness of the outcomes. Researchers and teachers were found to be more effective in delivering the interventions than hired interventionists or paraprofessionals. This finding suggests both the importance of ensuring the instructor is trained in PA instructional methods and has a deep knowledge of PA skills and the developmental progression. This finding also indicates that students who are in need of the most instruction and support are given PA instruction by highly-qualified and trained implementers.

For ML and SWD subgroups, providing mostly code-based instruction in a small group or individual setting was found to be most effective. Ensuring that the instruction is mostly code-based can help to reduce the cognitive load for students by not overwhelming them with both PA and phonics skills alongside comprehension of longer texts with complex vocabulary. Providing clear and explicit instruction that supports decoding skills in

consistent and short small group lessons can have effective outcomes on their reading fluency which will support their reading comprehension in other settings (e.g., tier 1).

Lastly, it is not surprising that explicit instruction was found to be one of the most effective techniques. Thus, it is important for those implementing PA instruction use a systematic and explicit approach. In this same vein, the use of multimodal techniques, such as hand signals, word boxes, and finger stretching, were found to be effective for students at risk of having reading difficulties. Along with explicit instruction and multimodal techniques, providing corrective feedback to students to ensure that they do not perpetuate any misconceptions is a highly-effective practice. Taken together, the implementation of short and consistent PA lessons that are explicit, multimodal, and include corrective feedback can lead to students learning the foundational sound-based skills that will ultimately lead to their success in reading fluency and comprehension.

References

Ehri, L. C., Nunes, S. R., Willows, D. M., Schuster, B. V., Yaghoub-Zadeh, Z., & Shanahan, T. (2001). Phonemic awareness instruction helps children learn to read: Evidence from the National Reading Panel's meta-analysis. *Reading research quarterly*, 36(3), 250-287.

Foorman, B., Beyler, N., Borradaile, K., Coyne, M., Denton, C. A., Dimino, J., Furgeson, J., Hayes, L., Henke, J., Justice, L., Keating, B., Lewis, W., Sattar, S., Streke, A., Wagner, R., & Wissel, S. (2016). *Foundational skills to support reading for understanding in kindergarten through 3rd grade* (NCEE 2016-4008). Washington, DC: National Center for Education Evaluation and Regional Assistance (NCEE), Institute of Education Sciences, U.S. Department of Education. Retrieved from the NCEE website: http://whatworks.ed.gov.

Gioia, P., Ziegler, J., & Deauviau, J. (2024). Revisiting the causal effects of phonemic awareness on reading acquisition: insights from a systematic review and a large-scale longitudinal study.

Hall, M. S., & Burns, M. K. (2018). Meta-analysis of targeted small-group reading interventions. *Journal of School Psychology*, 66, 54-66.

International Dyslexia Association. (n.d.). Dyslexia Basics. [Website]. https://dyslexiaida.org/dyslexia-basics/

Melby-Lervåg, M., Lyster, S. A. H., & Hulme, C. (2012). Phonological skills and their role in learning to read: a meta-analytic review. *Psychological bulletin*, 138(2), 322.

Moats, L. C., & Tolman, C. A. (2019). LETRS (3rd ed.). Voyager Sopris Learning.

National Early Literacy Panel (2008). Developing Early Literacy: Report of the National Early Literacy Panel. Washington, DC: National Institute for Literacy.

National Reading Panel (U.S.) & National Institute of Child Health and Human Development (U.S.). (2000). Report of the National Reading Panel: Teaching children to read: An evidence-based assessment of the scientific research literature on reading and its implications for reading instruction.

National Center for Education Statistics. (2024a). English Learners in Public Schools. *Condition of Education*. U.S. Department of Education, Institute of Education Sciences. Retrieved April 18, 2025, from https://nces.ed.gov/programs/coe/indicator/cgf.

National Center for Education Statistics. (2024b). Students With Disabilities. Condition of Education. U.S. Department of Education, Institute of Education Sciences. Retrieved April 21, 2025, from https://nces.ed.gov/programs/coe/indicator/cgg.

Rehfeld, D. M., Kirkpatrick, M., O'Guinn, N., & Renbarger, R. (2022). A meta-analysis of phonemic awareness instruction provided to children suspected of having a reading disability. *Language, speech, and hearing services in schools*, 53(4), 1177-1201.

Rice, M., Erbeli, F., Thompson, C. G., Sallese, M. R., & Fogarty, M. (2022). Phonemic awareness: A meta-analysis for planning effective instruction. Reading Research Quarterly, 57(4), 1259-1289.

Ross, K. M., & Joseph, L. M. (2019). Effects of word boxes on improving students' basic literacy skills: A literature review. *Preventing School Failure: Alternative Education for Children and Youth*, 63(1), 43-51.

Suggate, S. P. (2016). A meta-analysis of the long-term effects of phonemic awareness, phonics, fluency, and reading comprehension interventions. Journal of learning disabilities, 49(1), 77-96.

Vollebregt, M., Leggett, J., Raffalovitch, S., King, C., Friesen, D., & Archibald, L. M. (2021). Evidence for complementary effects of code- and knowledge-focused reading instruction. Child Language Teaching and Therapy, 37(3), 300–320.

Wilson, S. (1998). Phonemic Awareness: A Review of Literature.

Wren, Y., Hambly, H., & Roulstone, S. (2013). A review of the impact of bilingualism on the development of phonemic awareness skills in children with typical speech development. *Child Language Teaching and Therapy*, 29(1), 11-25.

Appendix A: Studies Under Review

1. Anthony, J. L. (2020). For which children of economic disadvantage and in which instructional contexts does Earobics Step 1 improve kindergarteners' literacy? *Journal of Research on Educational Effectiveness,* 9(1), 54–76. https://doi.org/10.1080/19345747.2015.1055637

2. Cassady, J. C., Smith, L. L., & Thomas, C. L. (2018). Supporting emergent literacy for english language learners with computer-assisted instruction. *Journal of Research in Reading*, 41(2), 350–369. https://doi.org/10.1111/1467-9817.12110

3. Chai, Z., Vail, C. O., & Ayres, K. M. (2015). Using an ipad application to promote early literacy development in young children with disabilities. *The Journal of Special Education*, 48(4), 268–278. https://doi.org/10.1177/0022466913517554

4. Chapman, J. (2016). Results from a longitudinal early literacy intervention study: Expected and unexpected outcomes. *Kairaranga*, 17(2), 23–30. https://doi.org/10.54322/kairaranga.v17i2.208

5. Coleman, M. B., Fowler, K., Parater, A. L., Riley, M. J., Park, Y., & Moore, T. C. (2021). Combining teacher-led and technology-assisted instruction to improve phoneme blending to read words for elementary students with disabilities. *European Journal of Education*, 37(3), 759–772. https://doi.org/10.1111/jcal.12521

6. Coyne, M. D., Oldham, A., Dougherty, S. M., Leonard, K., Koriakin, T., Gage, N. A., Burns, D., Gillis, M. (2018). Evaluating the effects of supplemental reading intervention within an MTSS or RTI reading reform initiative using a regression discontinuity design. *Exceptional Children*, 84(4), 350–367. https://doi.org/10.1177/0014402918772791

7. Dussling, T. M. (2020). The impact of an early reading intervention with english language learners and native-english-speaking children. *Reading Psychology*, 41(4), 241–263. https://doi.org/10.1080/02702711.2020.1768977

8. Fien, H., Smith, J. L. M., Smolkowski, K., Baker, S. K., Nelson, N. J., & Chaparro, E. (2015). An examination of the efficacy of a multitiered 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

9. Flynn S., Erickson, S., & Serry, T. (2023). The impact of explicitly teaching word segmentation using a visual vowel hand sign system to help at-risk children learn to read and spell english: A proof-of-concept study. *Australian Journal of Learning Difficulties,* 28(1), 97–118. https://doi.org/10.1080/19404158.2023.2210602

10. Frates A., Spooner, F., Collins, B., & Peterson, P. (2024). The effects of an instructional package on reading skills for multilingual learners with extensive support needs. *Research and Practice for Persons with Severe Disabilities*, 49(3), 190–207. https://doi.org/10.1177/15407969241247815

11. Fuchs, D., Cho, E., Toste, J. R., Fuchs, L. S., Gilbert, J. K., McMaster, K. L., Svenson, E., & Thompson, A. (2021). A quasiexperimental evaluation of two versions of first-grade PALS: One with and one without repeated reading. *Exceptional Children*, 87(2), 141–162. https://doi.org/10.1177/0014402920921828

12. Gillon, G., McNeill, B., Scott, A., Denston, A., Wilson, L., Carson, K., & Macfarlane, A. H. (2019). A better start to literacy learning: Findings from a teacher-implemented intervention in children's first year at school. *Reading and Writing*, 32(8), 1989–2012. https://doi.org/10.1007/s11145-018-9933-7

13. Gonzalez-Frey, S. M., & Ehri, L. C. (2021). Connected phonation is more effective than segmented phonation for teaching beginning readers to decode unfamiliar words. *Scientific Studies of Reading*, 25(3), 272–285. https://doi.org/10.1080/10888438.2020.1776290

14. Helf, S., Cooke, N. L., & Konrad, M. (2014). Advantages of providing structured supplemental reading instruction to kindergarteners at risk for failure in reading. *Preventing School Failure: Alternative Education for Children and Youth*, 58(4), 214–222. https://doi.org/10.1080/1045988X.2013.798773

15. Hodgins, H., & Harrison, G. L. (2021). Improving phonological awareness with talking tables in at-risk kindergarten readers. *Research in Developmental Disabilities*, 115, 1–9. https://doi.org/10.1016/j.ridd.2021.103996

16. Joseph, L. M. (2018). Effects of word boxes on phoneme segmentation, word identification, and spelling for a sample of children with autism. *Child Language Teaching and Therapy*, 34(3), 303–317. https://doi.org/10.1177/0265659018805236

17. Kuppen, S. E. A., & Bourke, E. (2017). Rhythmic rhymes for boosting phonological awareness in socially disadvantaged children. *Mind, Brain, and Education*, 11(4), 181–189. https://doi.org/10.1111/mbe.12148

18. McBreen, M., & Savage, R. (2022). The impact of a cognitive and motivational reading intervention on the reading achievement and motivation of students at-risk for reading difficulties. *Learning Disability Quarterly*, 45(3), 199–211. https://doi.org/10.1177/0731948720958128

19. Messer, D. & Nash, G. (2018). An evaluation of the effectiveness of a computer-assisted reading intervention. *Journal of Research in Reading*, 41(1), 140–158.

https://doi.org/10.1111/1467-9817.12107

20. Metasala, J. L., & Kalindi, S. C. (2022). The effects of a computer-based early reading program on the literacy skills of kindergarten students. *Computers in the Schools*, 39(4), 373–393. https://doi.org/10.1080/07380569.2022.2127344

21. Miles, K. P., McFadden, K. E., Colenbrander, D., & Ehri, L. C. (2022). Maximising access to reading intervention: Comparing small group and one-to-one protocols of reading rescue. *Journal of Research in Reading*, 45(3), 299–323. https://doi.org/10.1111/1467-9817.12383

22. Nicholson, T., & Tiru, S. (2019). Preventing a summer slide in reading -- The effects of a summer school. *Australian Journal of Learning Difficulties*, 24(2), 109–130. https://doi.org/10.1080/19404158.2019.1635499

23. O'Callaghan, P., McIvor, A., McVeigh, C., & Rushe, T. (2016). A randomized controlled trial of an early-intervention, computer-based literacy program to boost phonological skills in 4- to 6-year-old children. *British Journal of Educational Psychology*, 86(4), 546–558. https://doi.org/10.1111/bjep.12122

24. Olszewski, A., Guo, Y., & Breit-Smith, A. (2018). The effect of a shared book-reading intervention on the story retelling and phonemic awareness of a third grader with disabilities. *Reading & Writing Quarterly*, 34(3), 233–247. https://doi.org/10.1080/10573569.2017.1390808

25. Partanen, M., Siegel, L. S., & Giaschi, D. E. (2019). Longitudinal outcomes of an individualized and intensive reading intervention for third grade students. *Dyslexia: An International Journal of Research and Practice*, 25(3), 227–245. https://doi.org/10.1002/dys.1616

26. Prahl, A. H., Jones, R., Schuele, C. M., & Camarata, S. (2022). Phonological awareness intervention using a standard treatment protocol for individuals with down syndrome. *Child Language Teaching and Therapy*, 38(1), 22–42. https://doi.org/10.1177/02656590211033013

27. Rahn, N. L., Wilson, J., Egan, A., Brandes, D., Kunkel, A., Peterson, M., & McComas, J. (2015). Using incremental rehearsal to teach letter sounds to english language learners. *Education and Treatment of Children*, 38(1), 71–91. https://dx.doi.org/10.1353/etc.2015.0000.

28. Ritter, C., Morrison, J. Q., & Sherman, K. (2021). Differential effects of self-graphing on self-monitoring of early literacy outcomes in kindergarten students. *Journal of Behavior Education*, 30, 559–577. https://doi.org/10.1007/s10864-020-09390-6

29. Shamir, H., Yoder, E., Pocklington, D. & Feehan, K. (2018). Using adaptive CAI to supplement literacy development in early learners. *Journal of Educational Multimedia and Hypermedia*, 27(3), 367–389. https://www.learntechlib.org/primary/p/178526/

30. Solari, E. J., Denton, C. A., Petscher, Y., & Haring, C. (2018). Examining the effects and feasibility of a teacher-implemented tier 1 and tier 2 intervention in word reading, fluency, and comprehension. *Journal of Research on Educational Effectiveness*, 11(2), 163–191. https://doi.org/10.1080/19345747.2017.1375582

31. Vollebregt, M., Leggett, J., Raffalovitch, S., King, C., Friesen, D., & Archibald, L. M. (2021). Evidence for complementary effects of code- and knowledge-focused reading instruction. *Child Language Teaching and Therapy*, 37(3), 300–320. https://doi.org/10.1177/02656590211014246

32. Wheldall, R., Glenn, K., Arakelian, S., Madelaine, A., Reynolds, M., & Wheldall, K. (2016). Efficacy of an evidence-based literacy preparation program for young children beginning school. *Australian Journal of Learning Difficulties*, 21(1), 21–39. https://doi.org/10.1080/19404158.2016.1189443

33. Winn, T., Miller, J., & van Steenbrugge, W. (2020). The efficacy of a computer program for increasing phonemic awareness and decoding skills in a primary school setting for children with reading difficulties. *Australian Journal of Teacher Education* (Online), 45(12), 1–23.

34. Wise, N., D'Angelo, N., & Chen, X. (2016). A school-based phonological awareness intervention for struggling readers in early french immersion. Reading and Writing, 29, 183–205. https://doi.org/10.1007/s11145-015-9585-9

35. Zoski, J. L., & Erickson, K. A. (2017). Multicomponent linguistic awareness intervention for at-risk kindergarteners. *Communication Disorders Quarterly*, 38(3), 161–171. https://doi.org/10.1177/1525740116660817