Whitepaper

Putting Scientific Evidence to Work in Reading Instruction

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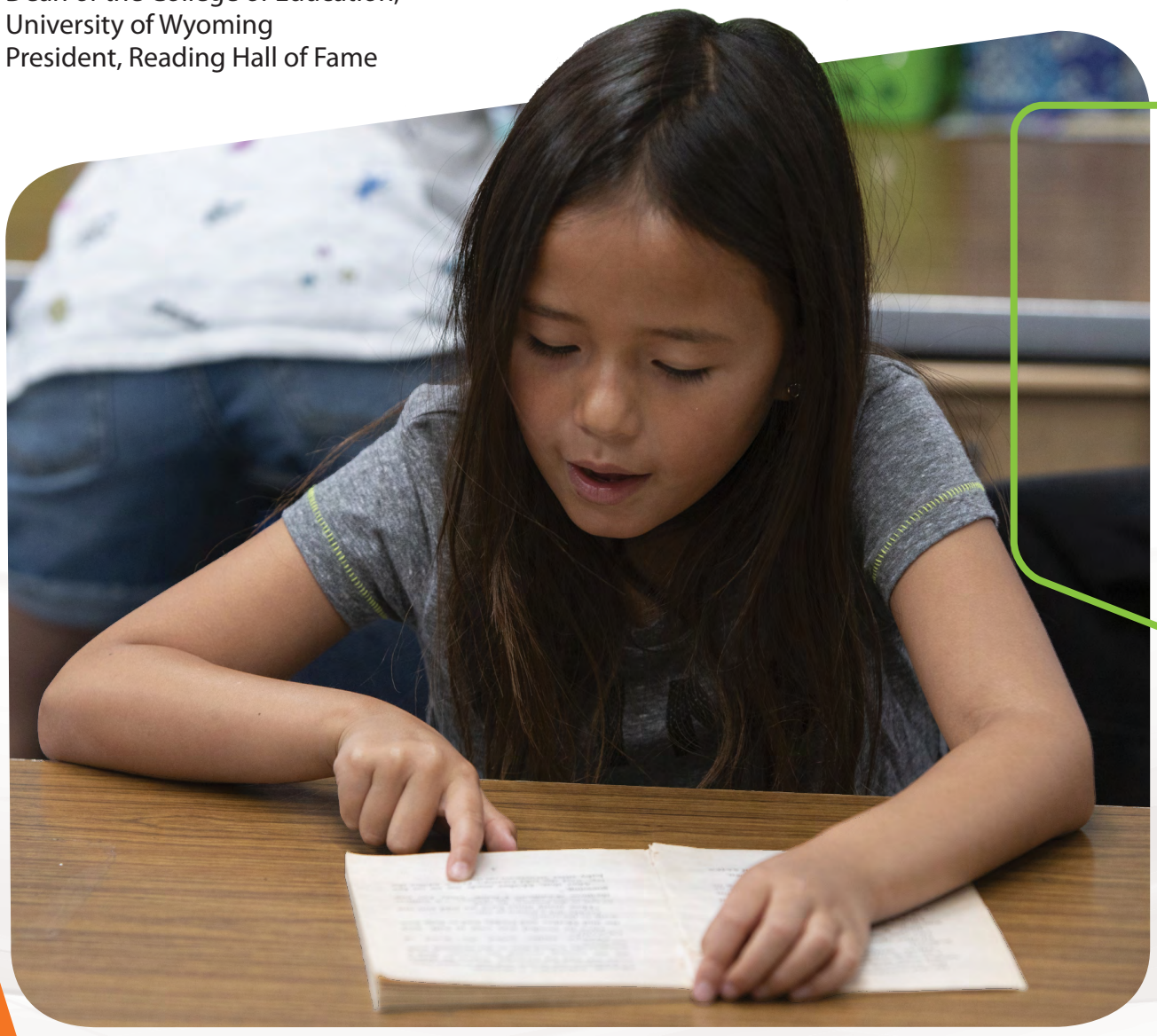

i-Ready

About the Author

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Dr. Reutzel is the author of more than 225 published research reports, articles, books, book chapters, and monographs in reading, early literacy, and early childhood education and has received more than $16 million in research and program development funding. His research on literacy earned him the William S. Gray Citation of Merit from the International Literacy Association in 2019. Ray is also an *i-Ready* Reading advisor.

The reading wars between proponents of

phonics-based and other approaches designed to teach children to read have been around for many years (Smith, 2002; Shanahan, 2020). The first modern iteration of the reading wars was touched off by Rudolph Flesch's 1955 book, *Why Johnny Can't Read and What You Can Do About It*. This book asserted that US students who could not read well at the time were struggling due to a lack of intensive phonics instruction after decades of receiving whole-word instruction as exemplified in the popular *Dick and Jane* readers (Gray, Monroe, Artley, & Arbuthnot, 1956). Since then, several iterations of the reading wars have ensued, including the Scientifically Based Reading Research (SBRR) debates that occurred in the early 2000s.

The reading wars have resurfaced again under the banner of Science of Reading—a term first popularized by journalist Emily Hanford in 2018. Now barely a day goes by without a national headline, somewhere online or in print, proclaiming the failure of educators to apply the findings of the Science of Reading in schools and classrooms (Rotherham, 2020; Shanahan, 2020; Wexler, 2019; Willingham, 2017). It is true that many children today are not learning to read proficiently. Currently in the United States, only about one-third of fourth grade students are reading proficiently (National Center for Education Statistics, 2019). Unfortunately, research shows that if students do not learn to read and write early and well, there can be long-term consequences. Tragically, low levels of literacy can be a real-life disaster for young students.

For classroom teachers, headlines such as these are a source of frustration and confusion leading to a condition some teachers call *curricular whiplash* and have driven the faculty of many teacher education programs into heated debates about the nature of science itself and what counts as knowledge. Exacerbating this is the fact that students' reading proficiency scores on state, national, and international assessments have remained stubbornly flat for decades. This leaves all too many students struggling to read and write proficiently enough to thrive in today's complex, information-dense society.

This whitepaper on the Science of Reading is intended to serve the following purposes:

1. **Answer the question "What does the term *Science of Reading* mean?"**

2. **Describe what the Science of Reading reveals** about how people learn to read.

3. **Draw a clear distinction between the terms Science of Reading and Science of Reading Instruction**, owing to the difficulty of translating basic research findings directly into effective instructional recommendations for teaching reading.

4. **Outline what the Science of Reading Instruction supports as general and specific instructional practices, approaches, and products** as well as those practices, approaches, and products that are lacking support by the current corpus of scientific instructional research studies.

1. What Is Meant by the Term "Science of Reading"?

There are many definitions of the term "Science of Reading," but for the purposes of this paper, we have selected a definition provided by the world's largest organization devoted to advancement of reading and literacy, the International Literacy Association:

> *The Science of Reading is* ***"a corpus of objective investigation and accumulation of reliable evidence about how humans learn to read and how reading should be taught."***
>
> —International Literacy Association, 2020

So what has this corpus of objective investigation and accumulation of reliable evidence revealed about how people learn to read? In exploring this further, we are going to distinguish between "how humans learn to read" (Science of Reading) and "how reading should be taught" (Science of Reading Instruction).

2. What Does the Science of Reading Reveal about How People Learn to Read?

In her best-selling book, *My Stroke of Insight: A Brain Scientist's Personal Journey*, Harvard-trained neuroanatomist Jill Bolte Taylor recounts in detail her loss of physical and intellectual abilities after suffering a massive stroke. As she recovered, Taylor (2008) explains that learning to read was the most difficult thing she had to relearn. Reading, she notes, is an enormously abstract and complex cognitive skill.

And we routinely expect that children will learn this enormously complex skill at age 5 or 6. What do we know about how reading works in the human mind? In the next sections, we will describe the basic pillars of how children/students learn to read. (Willingham [2017], in his book *The Reading Mind: A Cognitive Approach to Understanding How the Mind Reads*, also offers an accessible *tour de force* in answer to this question.)

Decoding Letters to Recover Speech Sounds

Writers use the alphabet to code spoken language into written language. In simplest terms, readers decode writing in order to recover their spoken language. Decoding allows learners to access the spoken word and its meanings stored in long-term memory by converting symbols into sounds, a process commonly known as "sounding it out." Decoding letters to recover speech sounds can occur in two ways—either by sounding out each letter in a word or by recognizing a specific spelling pattern to pronounce a word.

Readers begin the road to reading by learning to sound out each letter in a word. In order to do this, readers must learn to:

- Visually distinguish one letter from others
- Hear individual sounds in speech
- Know how to connect or map speech sounds onto letters

Combining these skills isn't easy. Humans are not born with the innate ability to hear individual speech sounds (i.e., phonemes), yet success in learning to read is causally related to the ability to discriminate speech sounds in the stream of spoken words we hear every day (Adams, 1994; National Reading Panel, 2000; Petscher, Cabell, Catts, Compton, Foorman, Hart, . . . & Wagner, 2020). Contrasted with many other languages, English uses a complicated and only somewhat reliable system of mapping speech sounds to letters—reliable enough, at least, that most children can learn to do it.

As readers continue to develop, they need to learn how words look when letters are grouped together into spellings. Spelling patterns, or *orthographic patterns*, provide a way for humans to recognize larger, distinct representations of spoken sounds. Developing the ability to map sounds to specific spellings can also help readers make better use of their "working memory" capacity.

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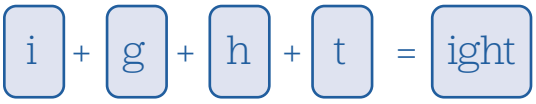
Consider this pattern: –ight (as in sight, fight, light). Instead of mapping four individual speech sounds to four individual letters (*i, g, h, t*), the mind is able to map a single "chunk" of sound to this particular orthographic pattern.



Recognition of spelling patterns occurs through instruction and feedback as well as through reading and writing. Early readers use both pathways—sounding out each letter in a word and recognizing a specific spelling pattern—to pronounce a word, and then connect the words they pronounce to meanings stored in long-term memory. When readers can use both pathways, it makes reading more efficient by requiring less attention in working memory and thereby making more cognitive resources available for comprehending the meaning of text.

Mapping Words to Meanings

Next, the decoded words must be mapped to one or more meanings stored in long-term memory. With some unknown words, the words around the unfamiliar word can act as context clues for figuring out the potential meaning. This is an effortful process that interrupts the flow of reading. Readers can also find meaningful clues within words. Affixes, better known as prefixes and suffixes, are an example of meaningful units that attach to base or root words, also providing clues that help readers figure out word meanings.

Consequently, a deep and broad array of word meanings stored in long-term memory, coupled with additional information from context clues and meaningful word parts, gives students access to their corpus of known word meanings. This corpus includes a single meaning for each of many words, and in some cases, many meanings for a single word.

A reader's vocabulary is developed through a combination of exposure to word meanings in print and in oral language, explicit instruction of word meanings, and through encouraging a curiosity about or interest in words and word meanings. With a large store of word meanings available to the mind, cognitive attention can be directed toward comprehending increasingly larger units of written language to include phrases, sentences, and connections among sentences.

The process of applying the alphabetic principle to read words and link those words to meanings generally solidifies for typically developing readers by the end of second grade. Students with reading difficulties including dyslexia may exhibit difficulty with phonological processing, and generally require more intensive instruction in decoding and word recognition strategies beyond second grade. Difficulties with reading comprehension may also be due to delays in language or meta-cognitive skill development. Early literacy screening is essential for identifying students who exhibit reading difficulties and require targeted instructional reading support.

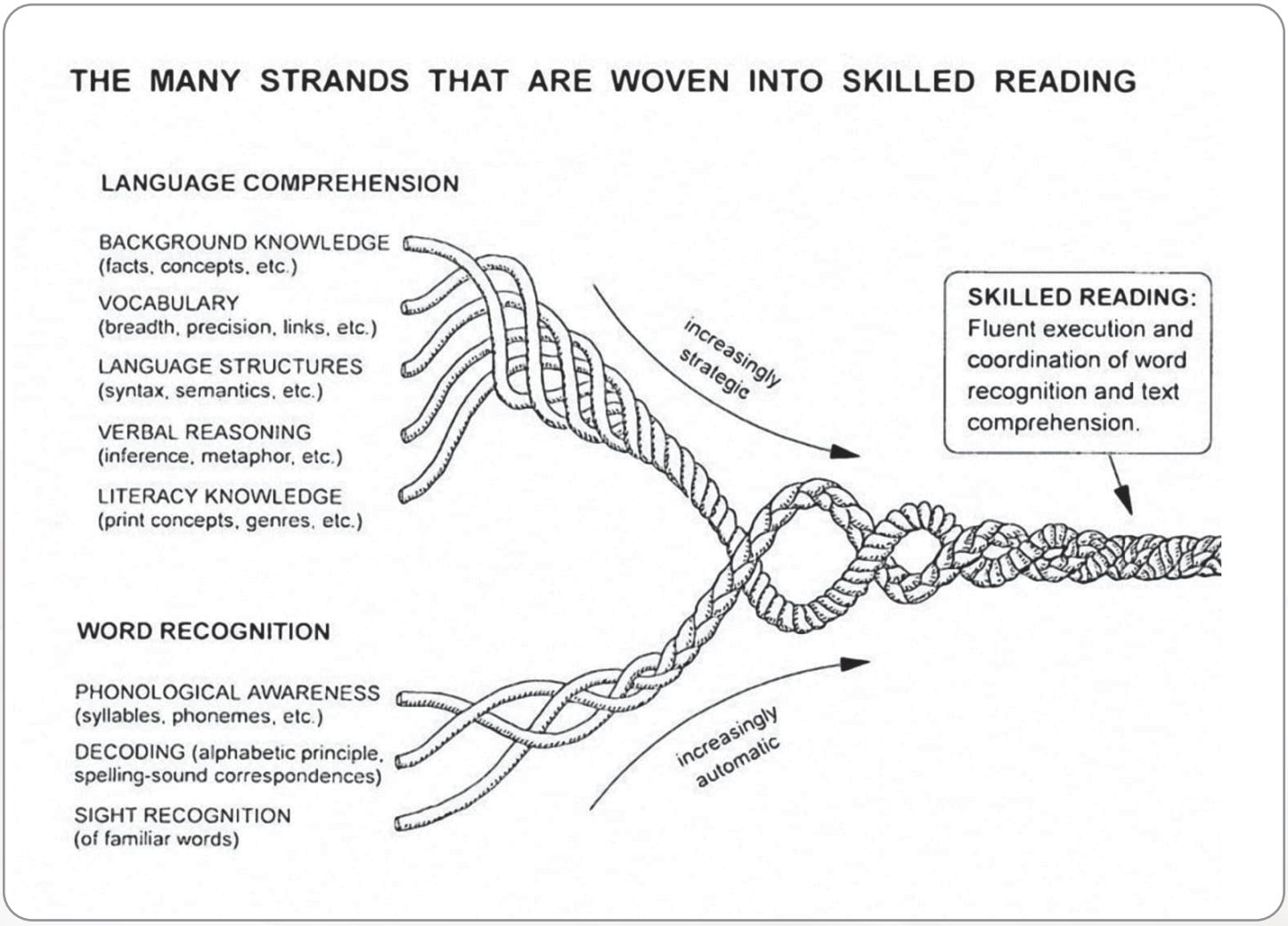
Comprehending Text

Readers comprehend text by accessing three levels of idea representation:

1. Sentences
2. Connections among sentences
3. A general notion of what the text is about

One major contributor to comprehension is a reader's background knowledge as well as their knowledge of oral language and its structures. Readers who have broad, deep, and well-organized world knowledge, who have large oral language vocabularies, and who have been exposed to varied language structures in oral language are greatly advantaged over readers who do not.

Readers use comprehension strategies when they need to make an effort to construct meaning in complex texts. Additional effort is usually required when their background knowledge is inadequate, poorly organized, or erroneous, when the text genre is unfamiliar, or when the text requires the reader to make a great many inferences. Understanding how the reading mind works can provide insights into potential instructional interventions intended to support or scaffold readers as they become increasingly proficient.



The above image originally appeared in the following publication: Scarborough, H. S. (2001). Connecting early language and literacy to later reading (dis)abilities: Evidence, theory, and practice. In S. Neuman & D. Dickinson (Eds.), *Handbook for research in early literacy* (pp. 97–110). New York, NY: Guilford Press. Used with permission from Guilford Press.

3. Working toward the Science of Reading Instruction

It is important to draw a distinction between two terms: *Science of Reading* and the implications of that term for reading instruction, or the *Science of Reading Instruction*.

The **Science of Reading** is based on basic empirical research studies that describe the processes that underlie how children become proficient readers.

The **Science of Reading Instruction** is based on applied empirical research studies that validate the effectiveness of instructional recommendations about how to teach humans to read.

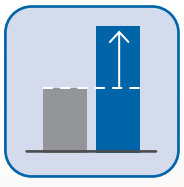
The term Science of Reading is used today by some to make pedagogical and policy claims based on basic research done in the cognitive sciences and neurosciences, particularly as it pertains to beginning reading (Seidenberg, 2017 as cited in Shanahan, 2020). Shanahan goes on to say that the Science of Reading term "is a bit of a misnomer" because people are taking the basic research and using it to prescribe instruction, which he argues is a conversation that is more about the Science of Reading Instruction than the Science of Reading as defined above. Shanahan (2020) explains the problem of translating basic research findings of the Science of Reading into instructional practices to support the Science of Reading Instruction as follows:

> "No matter how scientific basic research may be, ultimately any science of [reading] instruction will have to depend on applied studies of teaching, that is, those studies that require smaller inferences to application . . . . No matter how sound the studies of neural processing, perception, and memory, we must recognize the possibility that they, at least in some cases, could be irrelevant, inconsequential, or misleading with regard to teaching."

To sum up this distinction, no matter how well the corpus of basic research findings supports the science of *how* we learn to read, recommendations for instruction must be studied and replicated in the intended context of their use and with the intended recipients of their assumed benefits to support the growing body of research on the Science of Reading Instruction.

Duke and Martin (2011) describe another problem with translating basic research findings into applied recommendations: the difference between *research based* and *research tested*.

Research based means "that the particular practice, approach, or product has not been tested in a research study but has been designed to be consistent with [other related] research findings."



Research tested means that "one or more research studies tested the impact of that particular practice, approach, or product."

In view of this distinction, the Science of Reading Instruction should firmly rest upon research-tested rather than research-based empirical findings.

In making these distinctions between research-based versus research-tested claims, what are we really saying? We are not suggesting that we do not know anything about how to teach reading effectively. On the contrary, we do! For example, we do know that a scope and sequence is important—teaching young readers phonics explicitly and systematically yields consistent, tangible benefits in learning to read early and well (Ehri, 2004; Armbruster, Lehr, & Osborn, 2001). On the other hand, we do not know whether teaching one specific scope and sequence of phonics

skills and concepts rather than another results in improved reading outcomes. As we talk about translating what has been learned from the Science of Reading into specific instructional practices or programs, there are limitations to what we know. In order to claim that any particular instructional practice or program is supported with scientific evidence, it needs to be research tested. The research testing done must meet clear and broadly accepted scientific research evidentiary standards.

Instructional programs should be research based and use research-tested instructional methods. These instructional programs can also undergo research testing themselves. To help educators choose instructional programs that improve outcomes for students, the Every Student Succeeds Act (ESSA) defines four levels of evidence with level 1 being the highest, designed to help educators understand whether a program is research based, research tested with scientific evidence, or both.

Many current basal or core reading programs use instructional methods that are not research tested, though they may claim to be research based. Teachers and school leaders should attempt to find converging evidence from a variety of sources to support the adoption and use of instructional practices, products, or approaches that at least demonstrate a rationale (ESSA level 4 evidence) for being research based when strong or moderate evidence about being research tested is currently unavailable.

4. The Science of Reading Instruction: What Works in Teaching Reading

The scientific findings about reading instruction are often clustered into two broad instructional categories: how to teach foundational skills and how to teach reading comprehension. To construct meaning when reading complex texts, students need to develop solid reading foundational skills coupled with substantial background knowledge and the ability to strategically deploy a collection of scientifically supported comprehension strategies. Both the seminal Report of the National Reading Panel (NICHD, 2000) and the Report of the National Early Literacy Panel (NELP, 2008) provide a synthesis of strong scientific evidence for teaching a collection of reading foundational skills to young students as well as activating background knowledge and the teaching of comprehension strategies leading to proficient reading ability. In addition to these sources, we highly recommend *How the Science of Reading Informs 21st-Century Education* by Petscher et al.

Teaching Reading Foundational Skills

The category of reading foundational skills includes:

- **Concepts of Print** Learn how print works, including directionality (i.e., left to right, top to bottom), print not picture, punctuation, number of words and letters, and ordinal concepts such as first, last, and middle (Reutzel, Oda, & Moore, 1989; National Early Literacy Panel, 2008).

- **Phonological Awareness** Learn to hear, identify, and manipulate units of oral language larger than a single sound or phoneme, including onsets, rimes, syllables, and words. For example, a kindergarten student can tap three times to count the number of words in the spoken sentence, "The dog ran." They can clap twice for the number of syllables in the word "window." They can segment and say the onset, /k/, and the rime, /an/, in the syllable "can" (National Reading Panel, 2000; National Early Literacy Panel, 2008; Petscher et al., 2020).

- **Phonemic Awareness** Learn to hear, identify, and manipulate individual spoken sounds (i.e., phonemes) in words and syllables. For example, a kindergartener can identify the three sounds in the word "mat": /m/ /a/ /t/. A first grader can also manipulate sounds in words by replacing the /m/ in mat with /s/ to form the word "sat" (Muter, Hulme, Snowling, & Taylor, 1998; Nation & Hulme, 1997; National Reading Panel, 2000; National Early Literacy Panel, 2008; Petscher et al., 2020).

- **Phonics** Learn the relationships between spoken sounds (i.e., phonemes) and the letters that represent these spoken sounds in written language. Students develop the skills of blending sounds of letters in words to read and segment sounds in words to write. Blending and segmenting sounds in words to read and write are often referred to collectively as "sounding out" (Ehri, 2020; National Reading Panel, 2000; National Early Literacy Panel, 2008; Petscher et al., 2020).

- **Morphological Analysis** Learn how to determine unknown word meanings by identifying meaningful word parts such as prefixes, suffixes, and other word endings (e.g., possession, plurals, and grammatical tense). Students learn how the addition of word parts to a root or base word changes meaning (e.g., read vs. reread) (Carlisle, 2000; Baumann, Edwards, Boland, Olejnik, & Kame'enui, 2003; Beck & McKeown, 2007; Goodwin & Ahn, 2013; Lesaux, Kieffer, Faller, & Kelley, 2010; Levesque, Breadmore, & Deacon, 2021; Petscher et al., 2020).

- **Spelling** Learn to use knowledge of orthographic or spelling patterns to accurately write the combination of letters to represent the sounds they hear in spoken words. For example, a second grader knows the spelling pattern of "tion" to represent the sound pattern of /shun/. When hearing the word "nation" and trying to spell it, they will spell it "nation" rather than "nashun" (Ehri, 2020; National Reading Panel, 2000; Petscher et al., 2020).

- **Fluency** Learn to read text accurately, with appropriate speed and expression to free up attention to be used to construct meaning from text. Fluency forms a bridge from decoding to comprehension (National Reading Panel, 2000; Rasinski, Reutzel, Chard, & Linan-Thompson, 2011; What Works Clearinghouse, 2016; Petscher et al., 2020).

These reading foundational skills need to be taught to beginning readers and, in some cases, older students who are struggling to read proficiently. Beginning readers need to learn how print works and how letters, sounds, and spelling patterns can be used to recognize and decode words. As important as reading foundational skills are, they cannot produce proficient readers on their own. Students also need instruction to help them build their background knowledge, language comprehension, expand their vocabulary, and deploy comprehension strategies strategically to become proficient readers.

Teaching Reading Comprehension

The reading comprehension category includes:

Oral Language Skills Learn about phrases, sentence structure, connecting terms, and discourse patterns (Silverman, Johnson, Keane, & Khanna, 2020; Petscher et al., 2020).

Vocabulary Development Acquire and use a vast knowledge of words and their meanings (Kamil, Borman, Dole, Kral, Salinger, & Torgesen, 2008; Petscher et al., 2020).

Background Knowledge Build and activate knowledge of the world, events, facts, experiences, and information (Cabell & Hwang, 2020; Hattan & Lupo, 2020; Kaefer, 2020).

Comprehension Strategies Learn to use a collection of scientifically researched comprehension strategies to unlock the meaning of difficult, unfamiliar, or complex texts (National Reading Panel, 2000; Reutzel, Smith, & Fawson, 2005; Shanahan, Callison, Carriere, Duke, Pearson, Schatschneider, & Torgesen, 2010; Petscher et al., 2020). These strategies include activating prior knowledge, retelling, and inferencing.

Text Discussion Participate in extended discussions of text with teachers and peers (Kamil et al., 2008; Petscher et al., 2020)

Writing Write for varied purposes and in differing genres, including writing about what is read to cement comprehension of text (Graham, Bollinger, Olson, D'Aoust, MacArthur, McCutchen, & Olinghouse, 2012; Graham, 2020).

Building background knowledge is an essential element of evidence-based reading comprehension instruction (Cabell & Hwang, 2020; Cervetti, Jaynes, & Hiebert, 2009; Kaefer, Neuman, & Pinkham, 2015). It needs to be a focus for both beginning readers and for all students throughout life. Readers benefit from acquiring background knowledge and the word meanings, language, and text structures that are used to represent that knowledge. Paris (2005) pointed out that reading comprehension is considered an "unconstrained" skill domain—meaning the number of word meanings, facts, information, text genres, and language structures are continually growing and changing and are essentially infinite. As a result, reading comprehension is a lifelong pursuit.

Knowing *what* to teach, from the accumulated evidence base of scientific findings about reading, is only part of the instructional puzzle. Scientific research on reading instruction can also guide our understanding of *how* to teach these skills. We turn our attention now to that very task, understanding what scientific findings tell us about how to effectively teach reading foundational skills and reading comprehension.

Instructional Practices Supported by the Science of Reading Instruction

There are many general instructional practices and approaches commonly used for teaching reading. After decades of research, scientific findings about reading instruction have confirmed which instructional practices and approaches are demonstrably effective in helping students become proficient readers. What we discuss here is not meant to be a comprehensive treatment of this topic, but we will highlight some of the most consistently supported instructional practices for teaching reading effectively based on the scientific evidence base.

Just as a competent physician would never prescribe a treatment regimen without conducting diagnostic tests, effective reading instruction must be predicated upon the systematic collection of valid, reliable, and meaningful assessment data (Afflerbach, 2018). Single assessments or test scores are never sufficient for making informed instructional decisions about reading instruction.

Assessment should drive instruction. Otherwise, instructional time is wasted teaching skills or concepts students already know, and there is significant risk of failing to teach skills or concepts students need to learn. Educators should use multiple assessment tools to screen, monitor progress, and diagnose how well students are doing in acquiring the reading foundational skills, the background knowledge, and the comprehension skills necessary to promote engaged and proficient reading.

Based on the metrics provided by assessment, instruction in reading foundational skills, building background knowledge, and comprehension should begin early in schooling—and it's crucial that this instruction be systematic. There are three components to systematic instruction:

1. Instruction should proceed according to a *defined scope of skills and strategies*, as well the knowledge, concepts, and domains to be taught.
2. These skills should be *taught in a planned sequence*, where more difficult or complex skills build on easier, simpler ones.
3. Instruction should include a *periodic review and reteaching cycle* that assures students have acquired and are retaining requisite reading skills and knowledge.

Research has also determined that the teaching of reading skills and strategies is best supported, with some exceptions, through the use of *explicit* instruction. Explicit instruction begins with a statement and an explanation of a learning objective focused on a requisite reading skill, strategy, concept, or knowledge domain. This is followed by teacher modeling of the cognitive processes involved in learning or using the skill, strategy, concept, or knowledge domain. Next, teachers guide students in practicing what has been taught and gradually release more responsibility to encourage independence.

Throughout these guided practice sessions, students are monitored and provided with corrective feedback. Once teachers are satisfied students can benefit from independent practice, they are given opportunities to use the skills, strategies, or concepts on their own. Finally, students are assessed and retaught, if necessary, to assure efficacy of the instruction and practice. Instruction is best if it proceeds at an intensive pace and is followed up on regularly and relentlessly in a multitiered system of supports (MTSS) until students achieve proficiency.

Effective reading instruction based on scientific findings also requires that students engage with a variety of challenging or complex grade-level texts. We know that students achieve greater growth in reading when they read somewhat challenging texts for their reading level (Morgan, Wilcox, & Eldredge, 2000; Barrett, Brown, Mohr, & Wilcox, 2017). We also know that selecting texts that align with student interests and allowing students to choose their own texts motivates them to read both inside and outside of school (Guthrie & Humenick, 2004; Fraumeni-McBride, 2017). Additionally, students benefit from explicit instruction in metacognitive monitoring of their own understanding of text during reading (National Reading Panel, 2000; Shanahan et al., 2010). Monitoring comprehension helps readers take appropriate "fix-up" actions to repair faltering comprehension in a timely manner.

The goal of reading instruction is to accelerate student reading growth, whether students are reading at, below, or above proficient levels for their grade (Fielding, Kerr, & Rosier, 2007). When students are reading below level, a year's growth for a year's instruction will never help allow them to catch up. Acceleration of reading growth beyond this pace is best assured by using what we know from the above scientific findings about reading and reading instruction.

Reading impacts our livelihoods, from academic and career success to self-advocacy, community involvement, and health. Recent events, including the worldwide COVID-19 pandemic, have heightened the realization that literacy is an equity issue. Inadequate reading skills not only impact students' academic aspirations, but also increase the risk for dropping out of school, low self-esteem, later incarceration, and severe, life-threatening depression and anxiety. To afford all students the opportunity to build a sustainable life, we simply must do better at incorporating scientific findings about reading and reading instruction in our classrooms. To achieve this, teachers and school leaders need to have a broad and nuanced understanding of scientific findings regarding how reading works in the human mind and how to teach humans to read proficiently.

Conversely, there are a number of recommended reading instructional practices and approaches that are not backed by sufficient scientific evidence to recommend their use, such as those that de-emphasize systematic instruction of foundational reading skills, or emphasize the three-cueing system or multisensory approaches. Teachers and school leaders selecting instructional programs and materials should confirm that instructional programs are using research-tested approaches backed by reading science.

Classroom teachers must also know when to supplement instructional programs, practices, activities, and approaches that are not supported by the Science of Reading Instruction. If your school or classroom is currently employing popular but unsupported reading instruction programs in any form, then steps should be taken to supplement the programs with resources that are based on research-tested approaches.

Find out more about Curriculum Associates' commitment to the Science of Reading Instruction.

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