



RESEARCH BRIEF:

The Science of Reading

Introduction

The ability to read, and read well, opens up doors academically, professionally, and personally, that are otherwise closed to those who cannot read with proficiency. According to U.S. government data, only one-third of fourth graders have the reading skills to be considered proficient, defined by the National Assessment of Educational Progress as, “demonstrating competency over challenging subject matter” (National Center for Education Statistics, 2000). Additionally, a third of fourth graders and more than a quarter of twelfth graders lack the reading skills to adequately complete grade-level schoolwork (National Assessment of Educational Progress, 2019). Unfortunately, students that still struggle with reading by the time they reach high school are unlikely to improve once they graduate. According to a study conducted in 2015 by the U.S. Department of Education, as many as 32 million U.S. adults, and 19% of high school graduates lack literacy skills (Literacy, Inc., 2020). While adults lacking literacy skills may be able to read basic text such as directional signs, simple instructions, etc., they aren’t able to process long passages of text or glean meaning from the type of academic language needed to safely and effectively navigate life. They are also far less likely to secure gainful employment, engage in voting, or stay up on news and other current events that impact their lives (Kutner et al., 2006). Indeed, nearly every aspect of being a productive, engaged citizen is, in some way, tied to reading ability.

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However, while we can all agree on the importance of literacy in general, the “best” way to teach reading has been a topic of debate for years. Older methods of reading instruction, largely based on tradition and observation, have been debunked by research conducted over the past forty years yielding tremendous, interdisciplinary insights into the process of learning to read, gathered from developmental psychology, cognitive neuropsychology, developmental linguistics, and educational interventions. This evidence-based body of knowledge is what we now refer to as the

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“Science of Reading” (Lyon & Chhabra, 2004). Based on these empirical findings, the Science of Reading indicates that students need explicit instruction in the critical elements of reading: phonemic awareness, phonics, fluency, vocabulary, and reading comprehension (NICHD, 2000). The key difference between the Science of Reading approach and other alternatives, is the inclusion of phonics to teach children to begin reading by manipulating the sounds in words. The inclusion of phonics and phonics related skills is crucial to ensuring reading success (Dakin, 1999).

Indeed, reading, how we learn to read, and best practices for teaching reading, are some of the most studied aspects of human learning. Dozens of journals publish empirical research on reading each year. If we are looking for consistency when it comes to findings on learning to read and teaching reading we need only to look at the vast body of research synthesized from English-speaking countries (NICHD, 2000; Rowe & National Inquiry into the Teaching of Literacy, 2005; Rose, 2006; National Early Literacy Panel, 2008). The volume, nature, and consistency, of current research supporting the Science of Reading is incredibly direct on the need for phonemic awareness, phonics, fluency, vocabulary, and reading comprehension, in addition to several other supporting areas such as spelling. If we want to advance reading ability anywhere on the planet we must imbed the Science of Reading into reading instruction.

Critical Elements of Reading

In a comprehensive report produced by the National Reading Panel (NICHD, 2000) several decades of scientific research were summarized clearly demonstrating that

effective reading instruction must address phonemic awareness, phonics, fluency, vocabulary, and comprehension.

Given the findings that these five elements are essential components of effective reading instruction, it is no surprise they were



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incorporated into both the No Child Left Behind Act and the Reading First initiative (Judkins et al., 2008). In addition, the Science of Reading shows us that reading instruction encompassing these five critical elements needs (1) to be systematic; (2) skills and concepts that are taught in a planned, logically progressive sequence; and (3) lessons that focus on clearly defined objectives stated in terms of what students will do (Learning Point Associates, 2004). The Science of Reading also validates the need for young readers to be exposed to multiple practice activities that are scheduled purposefully to help them master and retain new skills. Young readers also require opportunities to work on carefully designed tasks that allow them to apply what they have been taught. In addition, if we want our students to become proficient readers the Science of Reading asserts that assessments should be designed and used in a timely fashion to monitor skill acquisition, as well as students' ability to apply new skills, retain them over time, and use them independently (NICHD, 2000).

Phonemic Awareness

Phonemic awareness is the understanding that spoken language words can be broken into the smallest unit of spoken language called individual phonemes. Different than phonics, phonemic awareness focuses on the individual sounds of a spoken language. Students must first learn to listen for the sound (phoneme) of letters and words before they begin to understand how letters represent the sounds (grapheme) in written language (Yopp, 1992). The Science of Reading tells us that kindergartners and first graders must first demonstrate an understanding of spoken words, syllables and sounds to develop phonological awareness. Students are better positioned to succeed at reading and writing when they have a solid grasp of oral language starting in early infancy. The early language

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experiences students are exposed to at home, prior to the start of formal education, influence the development of later language comprehension (Lust, 2006). According to the latest research, literacy achievement and related language skills are highly correlated and in turn impact future reading and writing skills, even language skills acquired naturally during the preschool years are relevant to later instruction in reading and writing in the primary grades. Large discrepancies in oral language development and the gap between language-advanced and language-delayed

children grows throughout the elementary years (Pearson et al., 2020; Biemiller, 2001).

As they develop children typically learn aspects of the five domains of language: phonology; syntax; semantics; morphology; and pragmatics, as well as endless subtleties of high-level conversation skills. Each language domain plays an important role in later literacy learning (Koutsoftas, 2013):

- Phonemes make up the sounds produced when speaking.
- Syntax refers to the orderly grammar rules a given language requires for the construction of acceptable sentences.
- Concepts have semantic features and meanings.
- Morphemes are the smallest unit of meaning in a language.
- Pragmatics is the system of oral social rules that children learn in order to be considered “nice” or “naughty”.

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Young students must have a solid phonemic awareness in order to grasp the basic language skills required for reading, including hearing and the identification and manipulation of sounds in spoken words (Adams, 1990). From the perspective of oral language development, phonemic awareness provides a foundation for the development of all other language skills, including reading (Tankersley, 2003). Rich oral opportunities are critical for children, not only to expand vocabulary, but also to support the process of learning morphemes needed to modify words they are familiar with. Long before reading proficiency is achieved, oral language is the sole means by which to learn, share, and express important thoughts and ideas (Lemke, 1989). Before a child ever steps foot in a classroom the cognitive, social, and biological precursors for reading are put into place. For children learning an alphabetic language such as English, phonological awareness, specifically phonemic awareness, is an important aspect of early literacy skill attainment (National Research Council, 1998). To continue developing literacy skills, students need instruction in both foundational and comprehension reading skills that include phonemic awareness.

Phonics

Phonics is the understanding that there is a predictable relationship between phonemes¹ and graphemes² (Armbruster et al., 2001). Therefore, we can define phonics as a set of rules that specify the relationship between letters in the spelling of words and the sounds of spoken language. The purpose of phonics instruction, and ultimately the understanding of phonics,

¹ Phonemes are the sounds of spoken language.

² Graphemes are the letters and spellings that represent the sounds in written language.

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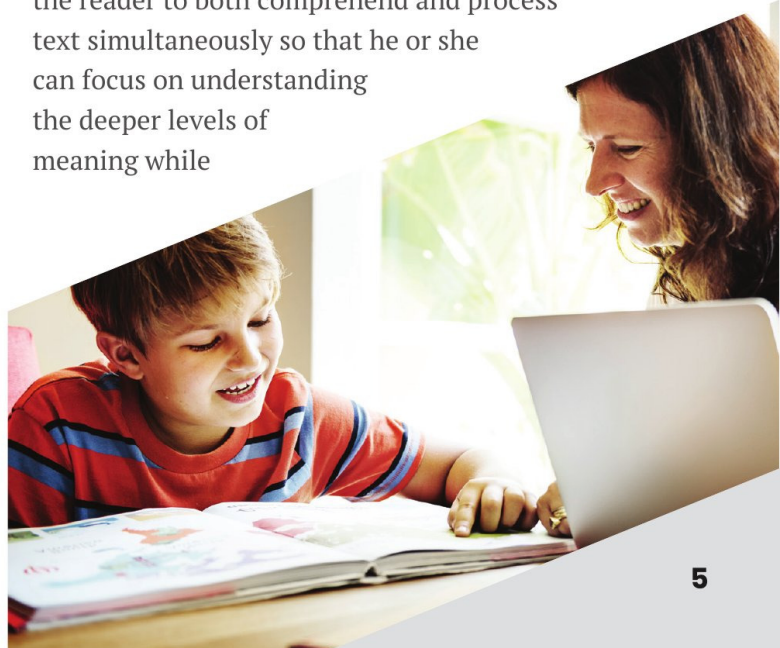
involves conceptualizing how written language was created. While the relationship between letters, the spelling of words, and the sounds of spoken language is not completely consistent when it comes to the English language, it is predictable enough to be very useful to young children when it comes to learning how to decode unfamiliar words (Foorman et al., 1998). Research-driven phonics instruction helps young readers make sense of the alphabetic principle and use it to become better readers. Because there is a systematic, if sometimes irregular, relationship between graphemes (letters and letter combinations) and phonemes (individual speech sounds), effective phonics instruction enables children to leverage these relationships to read and spell words accurately and rapidly. Good phonics instruction also serves as a memory aid to support students in their efforts to recall and apply rules and generalizations for matching sounds and letters (Rupley et al., 2009).

Findings cited in the National Reading Panel Report (NICHD, 2000) on the efficacy of systematic phonics instruction show that:

1. Systematic phonics instruction produces measurable gains in reading and spelling, especially when it comes to younger children at risk of being struggling readers.
2. When systematic phonics instruction is included as part of reading instruction, reading achievement is greater than if unsystematic or no phonics instruction is provided.
3. Younger students experience greater results than their older peers when receiving phonics instruction, making earlier phonics lessons key to future reading success.
4. Systematic phonics instruction produces gains regardless of whether it is used as a part of one-on-one, small group, and/or whole-class instruction.
5. When phonics instruction is included in reading lessons gains in reading are demonstrated by children from all socioeconomic levels.
6. Systematic phonics instruction improves comprehension and word recognition.

Fluency

Fluency plays a large role in general reading skills, as well as contributes to overall comprehension, helping to develop automatic word recognition and oral reading that sounds like spoken language (Kuhn, 2004). Reading with fluency requires the reader to both comprehend and process text simultaneously so that he or she can focus on understanding the deeper levels of meaning while



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mastering surface level text processing (Rasinski, 2004). Solid reading fluency requires independent reading done frequently, often, and with exposure to different kinds of texts. Specifically, if students do not read regularly, they are likely to lack fluency (Allington, 2012). While fluency fluctuates for every reader based on the complexity of the text, genre, general familiarity, and the purpose for reading (Fountas & Pinnell, 2006); a fluent reader is able to demonstrate text cues, solid comprehension and an awareness for finding the correct flow for what is being read (Newkirk, 2011).

Because many reading comprehension challenges are directly correlated with lack of fluency (Duke et al., 2004), in order to fully support students in their literacy achievements, literacy teachers must grasp the importance of fluency in terms of its effects on other reading skills. Fluency cannot fully develop if there are not frequent and sustained opportunities to practice reading across a wide breadth of genres and writing styles (Armbruster et al., 2001). If teachers want their students to experience a high degree of reading fluency, they must ensure that students are exposed to an expansive range of reading experiences and that students have access to a classroom library that engages them with diverse and relevant books. Research suggests that certain texts lend themselves to interpretive oral

reading more than others. These are the types of texts teachers should ensure end up in their classroom library and are being used in fluency instruction (Rasinski, 2006).

Vocabulary

Vocabulary, including that associated with academic language, is an important aspect of literacy learning (Heibert, 2020; Graves, 1986). Vocabulary comprehension allows students to interpret and understand content across a vast array of topics including that specific to textbooks, the type of academic language used in classrooms, and the language that encompasses assessments required to measure academic success and inform future academic placement (Pearson et al., 2007; Stahl, 2003). Students need

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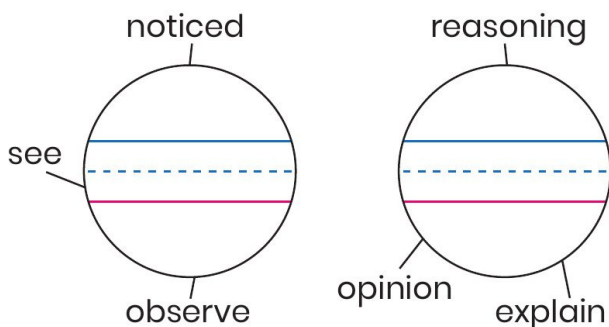
to master a high level of vocabulary in order to succeed in all other content areas, including math and science (Marzano, 2010). Every academic content area encompasses discipline specific vocabulary, grammar and punctuation that must be understood by students if they are to succeed in various academic disciplines and in school as a whole. Proficient reading attainment means students are able to use content-specific vocabulary and specialized, complex grammatical structures to acquire new knowledge and skills,

discuss topics with proficiency and share high-level information with others (Bailey, 2007).

Undoubtedly vocabulary, and the associated background knowledge needed to understand words, have a profound influence on students' ability to comprehend what they read. Background knowledge is evident in the vocabulary used in oral and written language, and the ability to acquire new vocabulary is linked to background knowledge (Fisher et al., 2012). For many teachers the push to teach new information can supersede vocabulary instruction. However, excluding

knowledge control the extent to which other reading comprehension behaviors are utilized. Amongst literacy researchers there is a clear consensus that accelerating vocabulary growth is a vital and often neglected component of a comprehensive reading program (Baumann & Kame'enui, 2004; NICHD, 2000). Research strongly shows that vocabulary proficiency and reading comprehension directly influence the other (Stahl & Fairbanks, 1987; Beck et al., 2002; Graves, 2000; Baker et al., 1995), in addition to affecting general reading ability (Stanovich et al., 1998).

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vocabulary from lessons is detrimental to student learning, as these skills are important tools for reading comprehension and other core reading skills. Vocabulary and background knowledge are widely recognized as critical factors for both academic learning and learning in general (Fisher & Frey, 2009; Kamil et al., 2008).

Additional research suggests that background knowledge and vocabulary are the strongest predictors of comprehension and that they indirectly influence whether or not students will apply higher order problem solving skills when they struggle to interpret advanced texts (Pearson et al., 2014; Cromley & Azevedo, 2007). Indeed, vocabulary and the associated background

Reading Comprehension

Reading comprehension is the key that unlocks additional learning and skills so that students are able to read increasingly more complicated texts, which in turn increases their capacity for future learning. Or rather the more students read, the more intelligent they are able to become, and this increases their general capacity for understanding (Kintsch, 2004). Reading comprehension is the, "ability to understand the meaning of what is said, or read, as well as its intent" (Cunningham & Zibulsky, 2013). When students are given ample opportunities to practice a system of strategic actions, such as complex processes involving the utilization of a wide range of skills, strategies, and conceptual understanding, they are engaging in the complex process of high-level comprehension (Duke et al., 2011; Serafini, 2010).



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In order to fully demonstrate reading comprehension many different components, relying upon a variety of different kinds of information and yielding complex mental representations, must come together into a cohesive understanding of what is being read (Kintsch & Rawson, 2005). Teachers must incorporate lesson plans and supports that build a system for processing texts and utilize skills rooted in earlier reading behaviors, so that the process recreates itself and allows students to read increasingly complex texts (Wallis, n.d.). Reading is the culmination of literary thinking from all aspects of the text (Serafini, 2010). Productive reading comprehension encompasses the process of finding meaning in text in order to construct a larger, deeper awareness within which the reader develops a relationship with what is being read (Snow, 2002).

Spelling

While spelling is not included as part of the five critical elements of reading, there is a vast body of research indicating that spelling and the five critical elements of reading are intrinsically

linked (Abbot et al., 2010; Caravolas et al., 2001). Most schools and teachers continue to regard spelling as an important part of the educational curriculum. Indeed, the majority of elementary schools nationwide provide spelling instruction and assess their students' spelling abilities (Fresch, 2003; Graham et al, 2008; McNeill & Kirk, 2014). Research has shown there is a reciprocal relationship between reading, writing and spelling, making spelling an important aspect of both the reading and writing process (Ehri, 2014).

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If students lack solid spelling skills, their reading and writing may suffer if they choose to limit their use of vocabulary to only words they are confident they can spell (Graham, 1999).

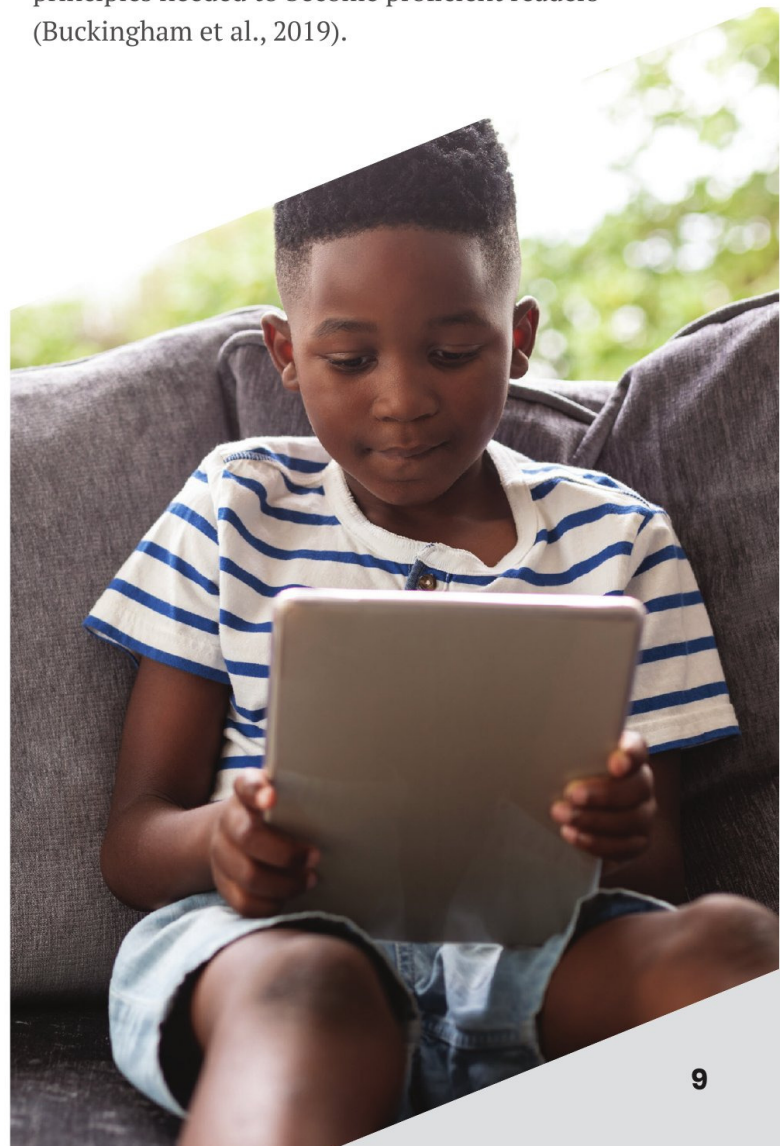


A 2012 Institute of Education Sciences' Practice Guide, indicates that students should be encouraged to learn words they frequently misspell, as well as words they wish to include in their writing (Graham et al., 2012). The guide also advises that teachers should help students acquire the skills they need to generate and check plausible spellings for words (Berninger et al., 2000; Berninger et al., 2002; Graham et al., 2002). In addition, the guide notes that when students are working on drafts, it is important for them to learn skills for applying spelling rules to words they wish to include, such as invented spelling or spelling by analogy. Because spelling-sound connections are retained in memory, they impact the processing of phonological constituents and phonological memory for words (Treiman et al., 2019). In fact, a very small number of words (850) make up 80 percent of the words elementary schools students use in their writing (Graham, Mckeown, Kiuahara, & Harris, 2012). As such, when students increase their grasp of spelling, sounding out and learning more difficult words, both their reading and writing improve.

Systematic and Explicit Reading Instruction

Systematic and explicit reading instruction incorporates carefully planned lesson sequences that provide a blueprint for student learning matched to students' developmental levels. This type of instruction is carefully thought out, incorporates a scope and sequence for content delivery, builds upon prior knowledge, moves from simple to complex concepts, and provides a framework for selecting the appropriate activities and resources to support lessons, including

a variety of word-study activities (Mesmer & Griffith, 2005). Systematic and explicit reading instruction also increases the likelihood that young readers possess the appropriate prior knowledge they need to successfully navigate more advanced concepts associated with the progression of learning to read (Adams, 2001). This type of instruction requires educators to focus on the details of the instruction process, is typically teacher directed, and is based on a logical analysis of the skills needed by readers to progress in an optimal sequence (Rupley et al., 2009). While systematic and explicit reading instruction is important across all aspects of the Science of Reading critical elements, it is especially crucial for phonics instruction, as systematic instruction ensures that students understand the alphabetic principles needed to become proficient readers (Buckingham et al., 2019).



Conclusion

The teacher preparation research group reports that as of 2019 more than half of teacher training programs teach the Science of Reading as compared to 35% in 2013. While teacher preparation programs are catching up to the scientific evidence on how the brain learns to read there is still some debate on *how* to teach the critical elements of reading (Drake & Walsh, 2020). Current teaching approaches differ in terms of how much guidance or direction teachers provide as their students are learning new reading skills, how clearly and directly teachers explain new skills, whether they demonstrate exactly how to use a specific skill, and whether the skills are taught in a thoughtful sequence. However, scientific research reviewed by the National Reading Panel (NICHD, 2000) indicates that the different approaches or methods of teaching the five essential components are not equally effective (Pearson et al., 2020). Indeed, they found that the most reliably effective approach to teaching reading is systematic and explicit instruction, especially when it comes to phonics, that incorporates the Science of Reading. If we want to create a world in which everyone is given the chance to be literate, we must use the Science of Reading to incorporate the five critical elements of reading into lessons that are engaging, relevant, systematic and explicit.



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