The Science of Reading at Your Fingertips

What You Need to Know

January 2026

The Science of Reading at Your Fingertips:

What You Need to Know

Literacy today

“We were never born to read. Human beings invented reading only a few thousand years ago. And with this invention, we rearranged the very organization of our brain, which in turn expanded the ways we were able to think, which altered the evolution of our species.”

Maryanne Wolf, 2008

Striving readers can face a lifetime of challenges.

75%

of non-proficient 3rd graders do not reach proficiency in future grades (Hernandez, 2012).

88%

of students who did not graduate on time were not proficient readers in 3rd grade (The Annie E. Casey Foundation, 2010).

4x

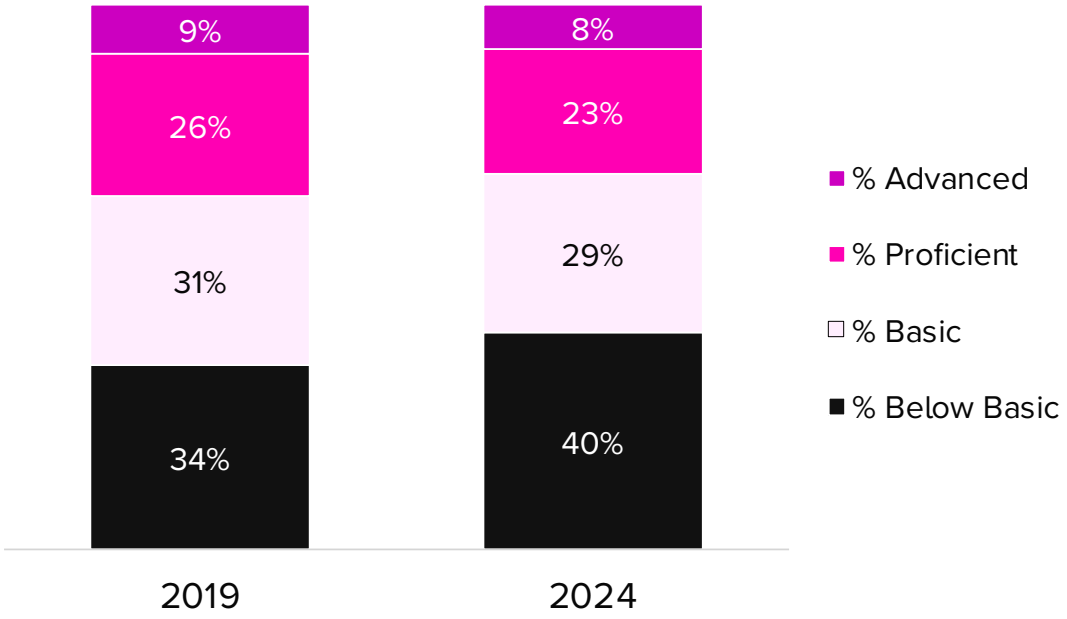
Students not reading proficiently by the end of 3rd grade are 4x more likely to dropout than those who are proficient readers (Hernandez, 2012).

2x

Among developed nations, individuals with poor literacy skills are more than twice as likely to be unemployed and are less likely to participate in civic activities (OECD, 2024; Schleicher, 2015).

An increasing number of students are not scoring proficient on the NAEP reading assessment, with 40% scoring in the below basic level.

Grade 4 NAEP Reading:
2019 and 2024 overall achievement-level results

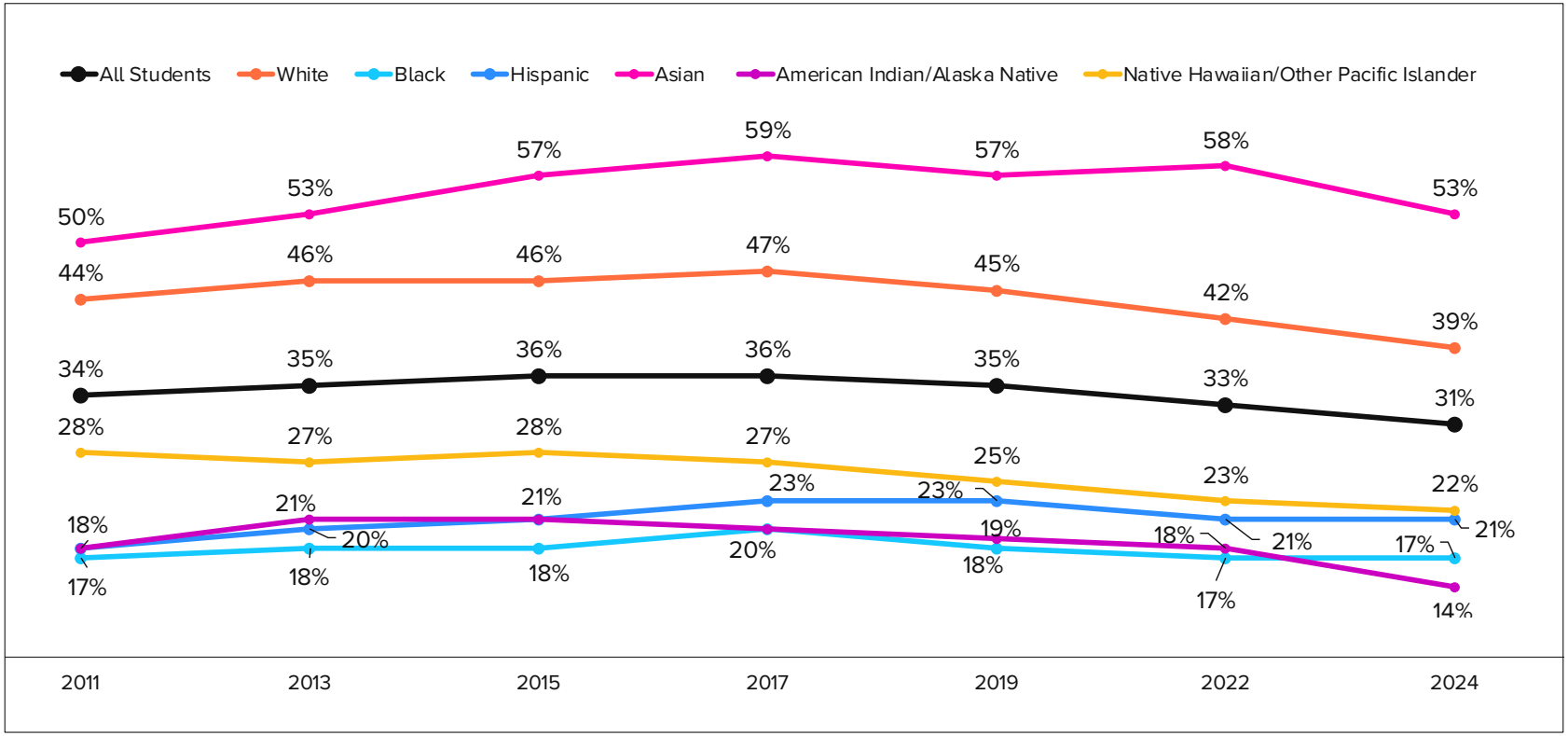


Source: U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), various years, 1992-2024 Reading Assessments.

There is an opportunity gap when it comes to reading.

Inequity in learning opportunities and socio-economic contexts has led to disparities in reading outcomes.

Grade 4 NAEP Reading % Proficient or Higher, by Race and Ethnicity

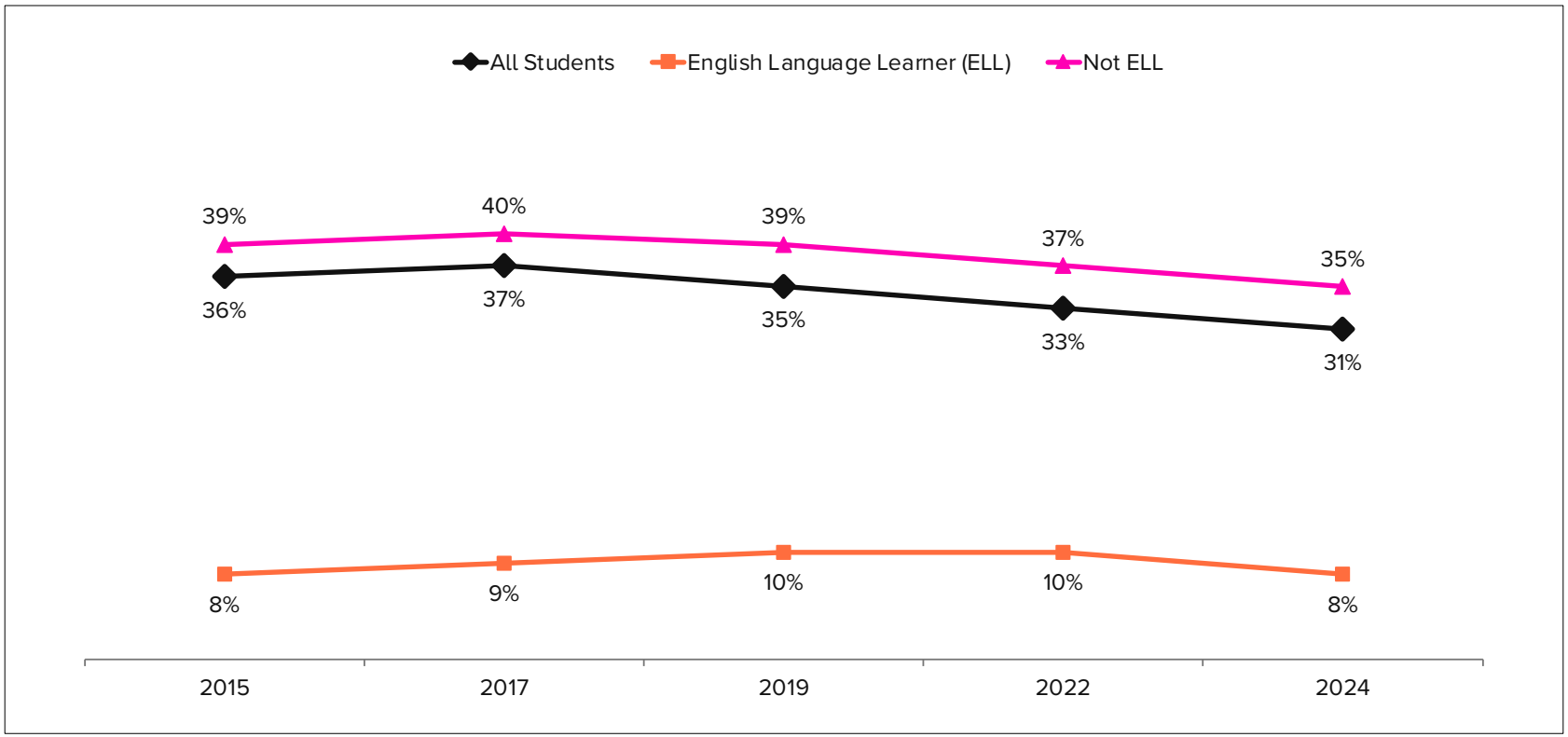


(U.S. Department of Education, 2025)

Equitable literacy opportunities can benefit all.

To close persistent gaps in reading achievement, we must strengthen opportunities for all learners by ensuring access to effective instruction and resources that support every student's success.

Grade 4 NAEP Reading % Proficient or Higher, by English learner status



(U.S. Department of Education, 2025)

What does it take to build a reading brain?

Features of effective literacy instruction

Grounded in the science of reading

Comprehensive and integrated

Differentiated and personalized

Empowers students, educators, and families

The reading process

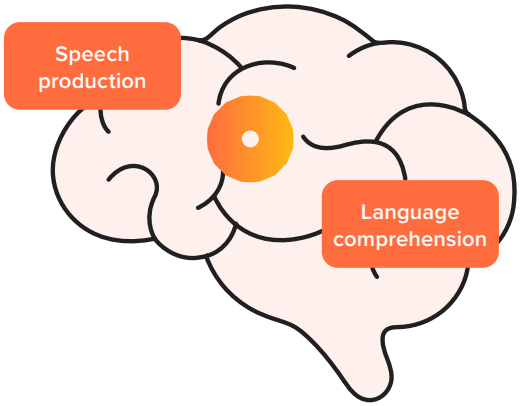
The Science of Reading

Is a body of evidence drawn from fields like cognitive psychology, educational psychology, neuroscience, and linguistics about how people learn to read.

Shows that reading and writing don’t come naturally; building a reading brain requires explicit, systematic, and cumulative instruction in key literacy elements.

(Castles et al., 2018; Gough & Hillinger, 1980; NICHD, 2000; Seidenberg, 2017; Templeton, 2021)

While spoken language is innate, our brains don't come wired to read and write.



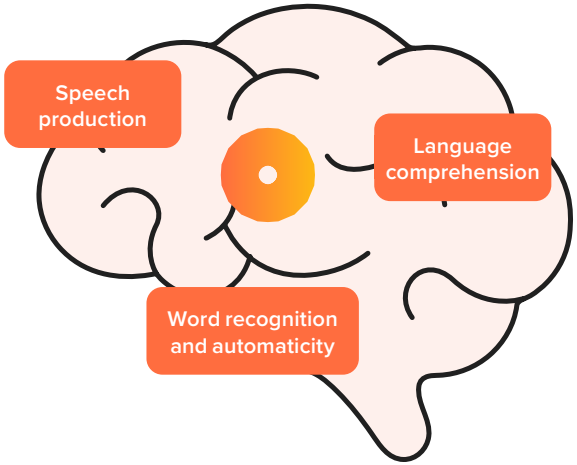
Spoken language is 70,000 years old, so our brains have had time to evolve structures to support speaking and listening. Barring developmental delays, children only need lots of input and informal practice to learn their first language (Harai, 2015).

200,000 years ago
***Homo sapiens* evolve**

70,000 years ago
First human language

~5,000 years ago
First writing system

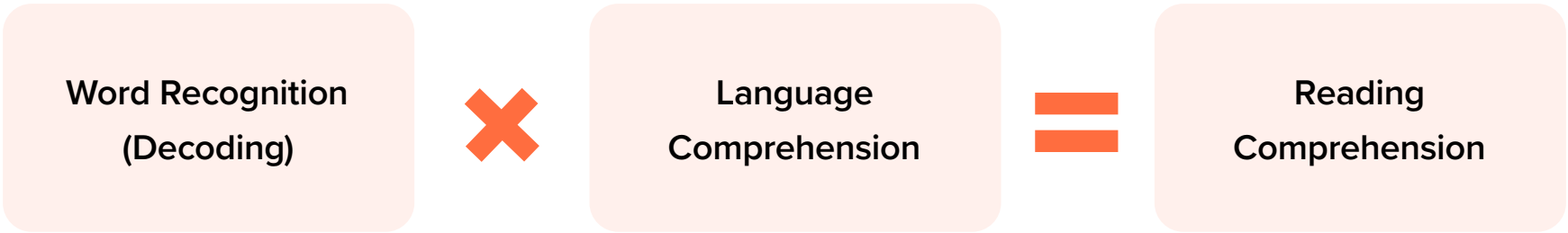
Written language is around 5,000 years old—too new for our brains to have evolved structures for reading and writing. A reading brain must create the Visual Word Form Area to recognize written words, and this requires explicit reading instruction (Dehaene, 2009).



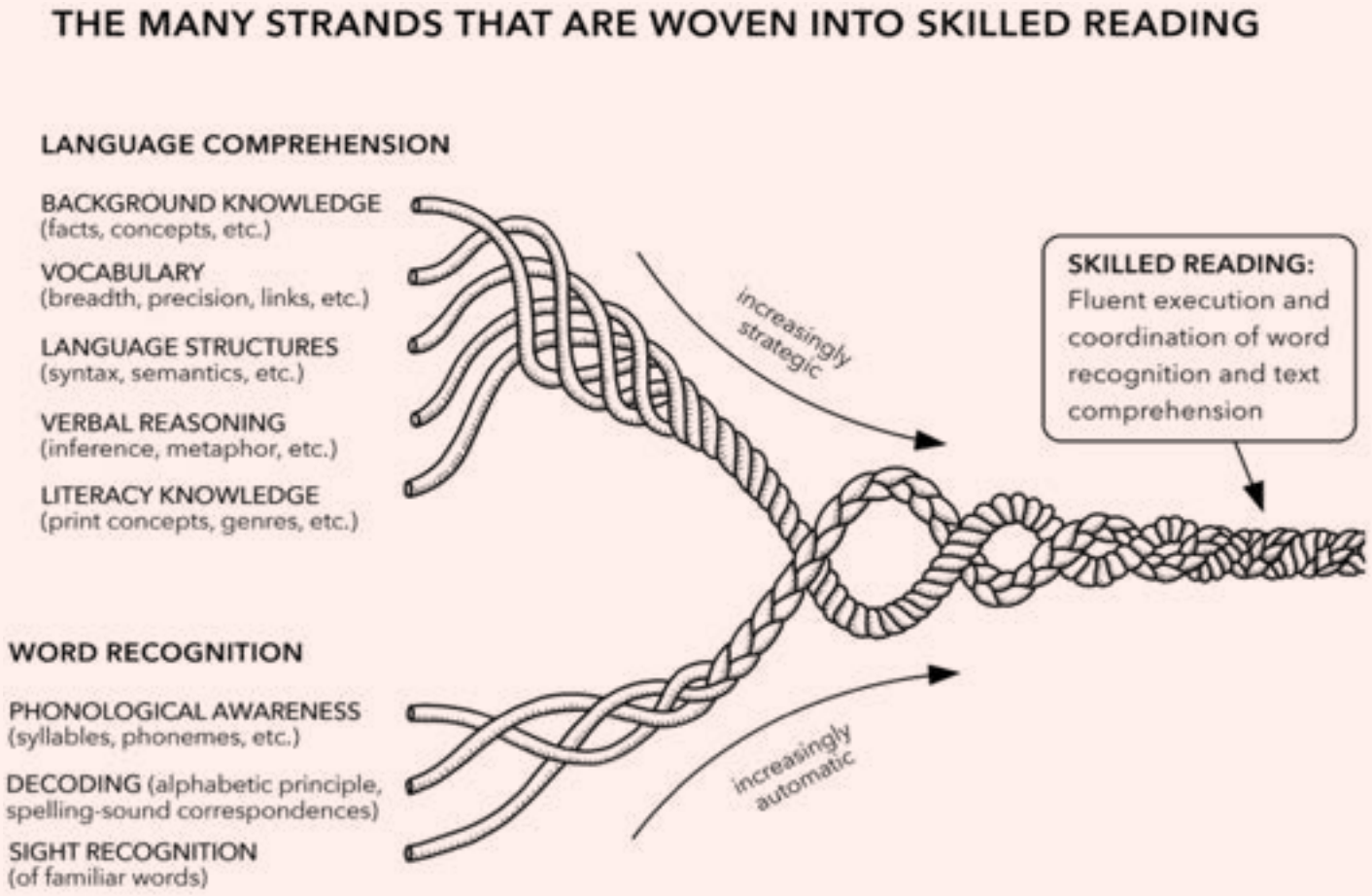
Skilled reading is an intricate process involving two essential and interdependent components: decoding and language comprehension.

The Simple View of Reading

(Gough & Tunmer, 1986)



Reading is a complex, multifaceted skill, acquired over years of instruction and practice.

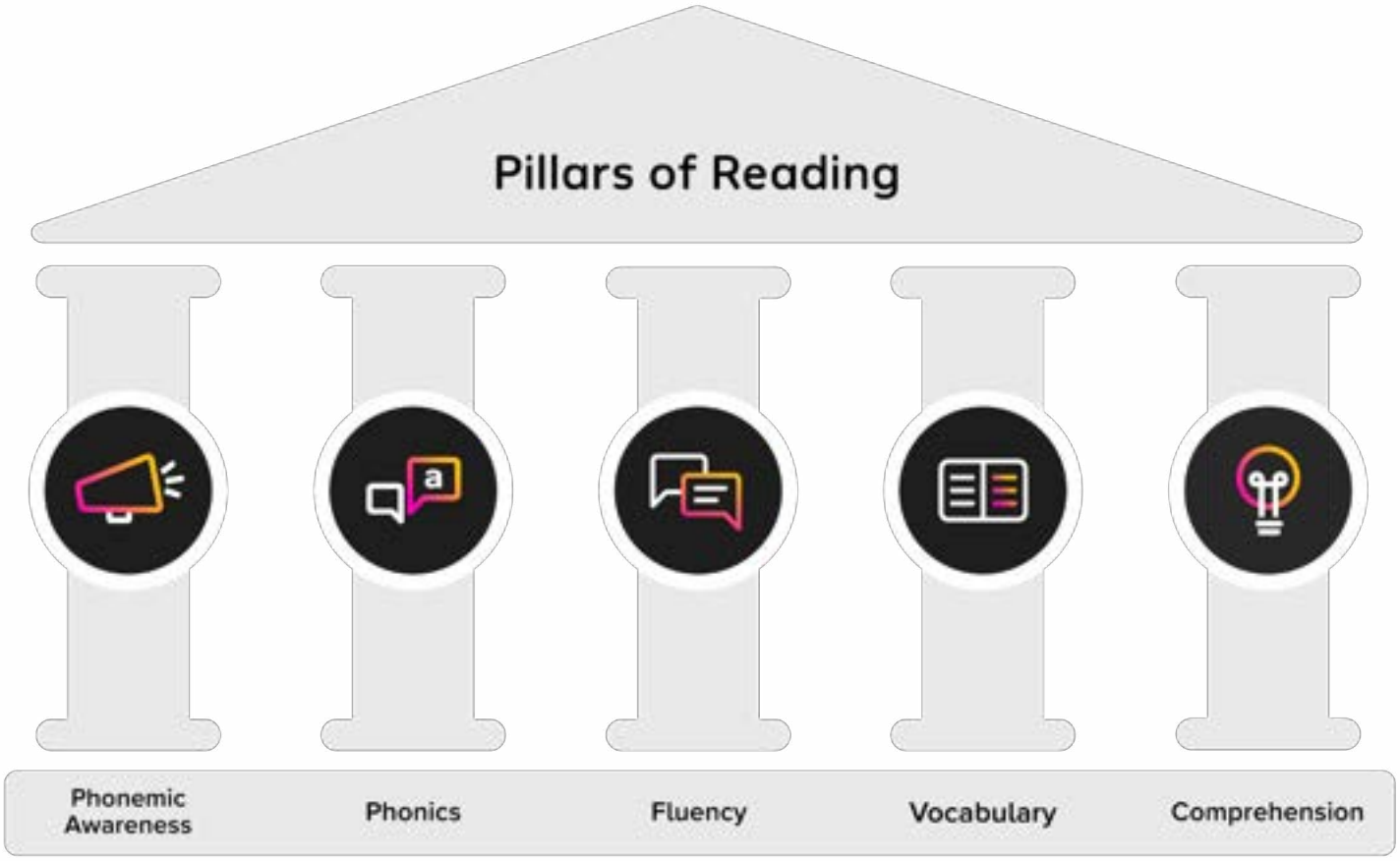


The image, used with permission from the Publisher, originally appeared in the following publication: Scarborough, H. S. (2001). Connecting early language and literacy to later reading (dis)abilities: Evidence, theory, and practice. In S. Neuman & D. Dickinson (Eds.), *Handbook of early literacy research* (Vol. 1, pp. 97-110). Guilford Press.

Essential elements

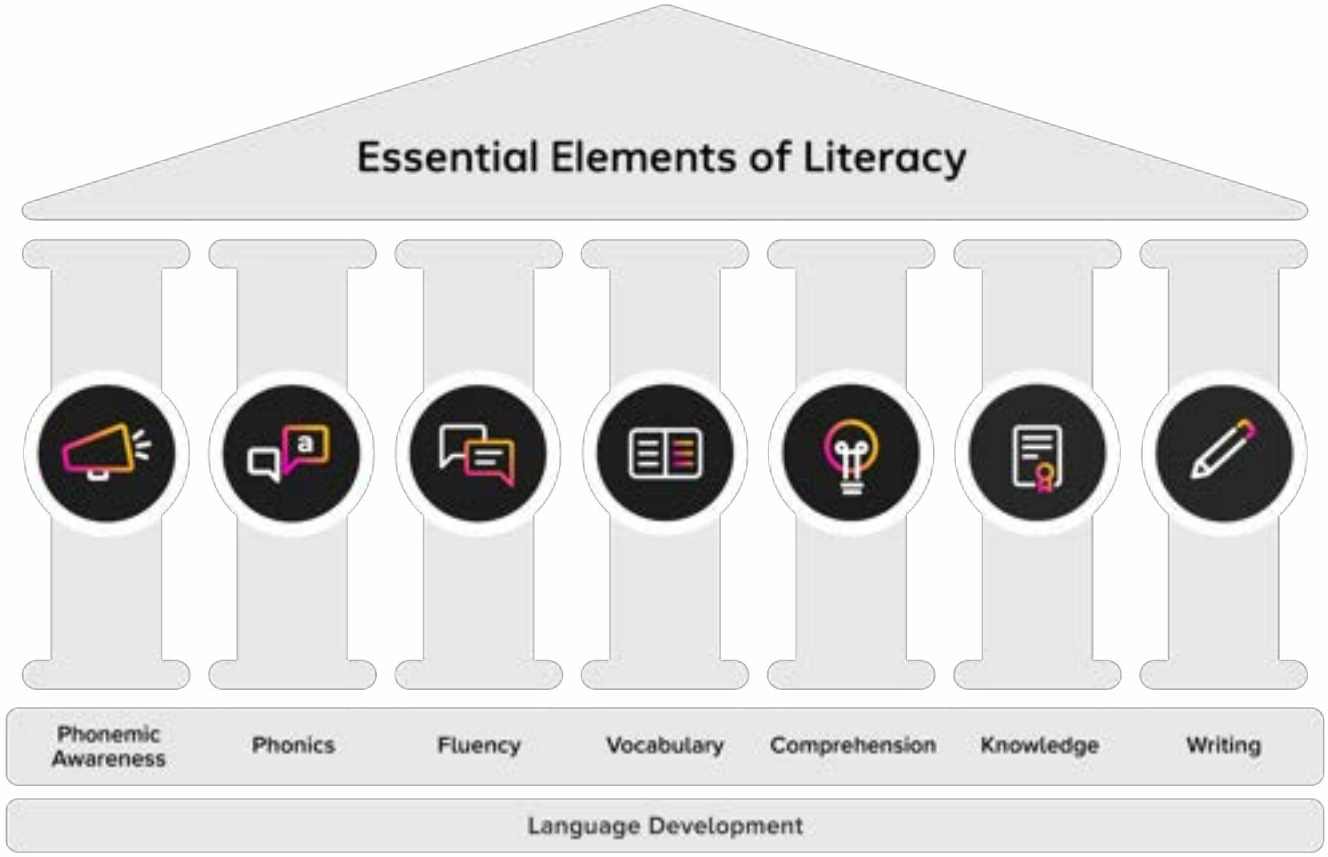
Building a reading brain requires effective instruction and practice.

The groundbreaking report by the National Reading Panel in 2000 was instrumental in establishing the five pillars of reading, which were determined essential for effective instruction (NICHD, 2000).



The Science of Reading continues to evolve and expand our understanding.

Over the last 20 years, numerous other factors have been identified as essential to literacy, including background knowledge, writing, language development, and the integration of assessment and positive learning behaviors and habits (Behring & Endo, 2020; Salinger, Alexander, Endo, & Behring, 2020).



It all starts with sounds.

"I see a rainbow. It's so pretty."

Written language is discrete; letters and words are clearly separated.

But language is a continuous waveform spoken without clear boundaries.

The first task in building a reading brain is distinguishing speech sounds, or phonemes, so they can be mapped to letters.

Phonemic awareness follows a developmental progression.

From continuous speech sounds
īsēərānbōĭtssōprĭtē
↓
To sentences
īsēərānbō. ĭtssōprĭtē.
↓
To words
ī sē ə rānbō. ĭts sō prĭtē.
↓
To rhyming and alliteration
rānbō rhymes with ĕlbō (elbow) and starts with the same sound as rŭn (run)
↓
To syllables
rān/bō
↓
To parts of syllables
r-ān/b-ō
↓
To phonemes
r-ā-n-b-ō

Strong phonemic awareness is a key prerequisite for learning to read proficiently.

Phonemic awareness is an important precursor to reading and serves a critical role in the reading development process because it helps students understand how spoken language connects to written language.

Try it: how many phonemes are in the word “exit”?

Hearing the phonemes in words isn’t easy, but it is essential.

“Exit” contains **5** phonemes.

The correspondence between letters and sounds is NOT 1 to 1.

letters	e	x		i	t
phonemes	ĕ	g	z	ə	t

If you didn't answer correctly, you're not alone. Many adults do not identify the accurate number of phonemes on their first try.

Phonemic awareness prepares the brain to link letters with sounds.

This letter-sound connection is what allows us to read words.

It's how we differentiate between similar-looking words like ***dip*** and ***bid*** and how we decode unfamiliar words like ***sesquipedalian***.

But the brain’s visual system doesn’t naturally recognize letter shapes.

Reading requires us to quickly make small but critical distinctions between letters, many of which are mirror images like “b” and “d.”

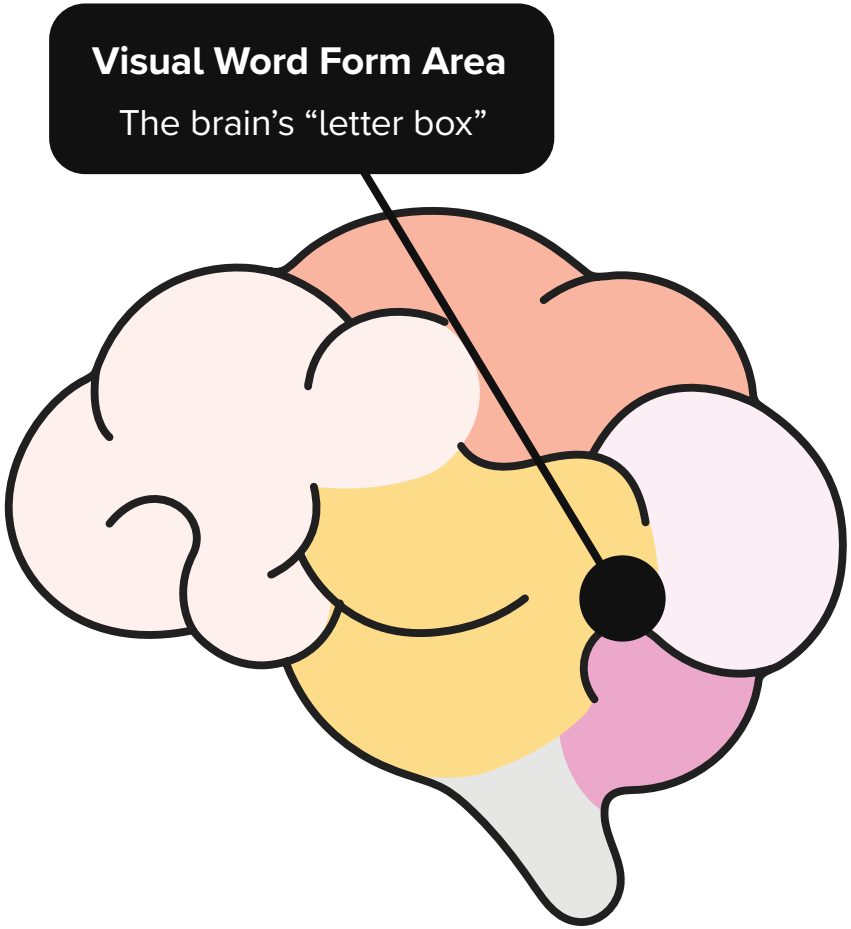
These distinctions are not as important when looking at a picture, since both images are still a lion.

b
p

d
q

Brains can change with instruction.

Our brains naturally specialize in recognizing things that have always been important to humans, like faces. Through schooling, the brain is able to repurpose some of the visual area that recognizes faces, places, and objects to recognize letters and words, creating the Visual Word Form Area (Dehaene et al., 2010).



Systematic phonics instruction activates the Visual Word Form Area.

(Dehaene, 2009)

Categories of phonics knowledge	
Letters	c-a-t, s-l-i-p
Letter combinations	c-oa-t, th-r-ee
Word families/Sound spellings	d-ay, st-ay, pl-ay
Syllables	cre-ate, pi-a-no
Morphemes	in-excus-able, im-poss-ible
Position-based spelling	catch vs. lunch

And fluency instruction strengthens it.

Imagine you're learning to read a new script where numbers are used instead of letters.

a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z
26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1

Use the code above to read the sentence below:

21 15 6 22 13 24 2 18 8 7 19 22 25 9 18 23 20 22 25 22 7 4 22 22 13

23 22 24 12 23 18 13 20 26 13 23 24 12 14 11 9 22 19 22 13 8 18 12 13.

If decoding this numerical sentence was painstakingly slow, you know what it feels like to be a beginning reader.

The brain can only pay attention to one thing at a time; if it's so focused on decoding word-by-word, it's hard to keep track of what the text means.

Fluency is the bridge between decoding and comprehension.

(Pikulski & Chard, 2005)

Reading fluency is the ability to read text accurately, quickly, and with appropriate expression. Fluency practice with repetition and feedback encourages instantaneous mapping of letters to sounds, leading to automaticity. Accuracy and automaticity reduce the cognitive load of decoding.

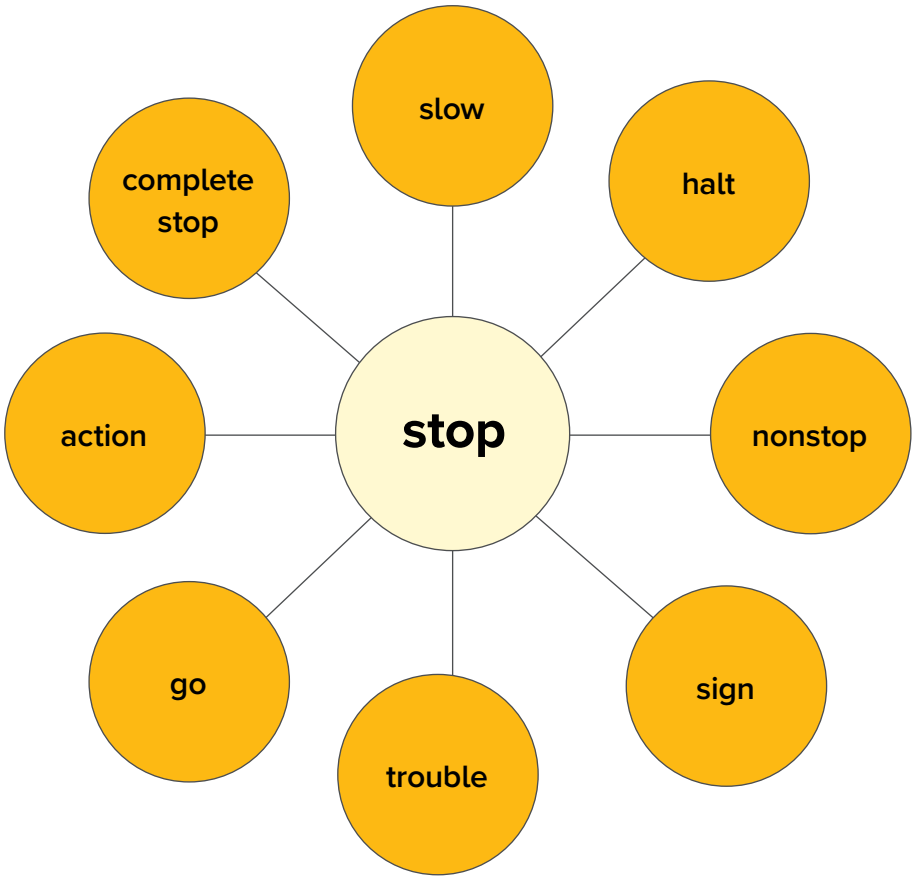
Prosody is reading with appropriate phrasing, intonation, and expression. When students read with prosody the brain attends to language and meaning, supporting comprehension.

Vocabulary is critical to understanding text.

Children's interaction with text should not be limited to what they can read on their own. Most students can more effectively engage with topics and ideas and learn accompanying vocabulary that stretches their growth when they listen to teachers read complex texts aloud and discuss the texts with peers (Willingham, 2017).

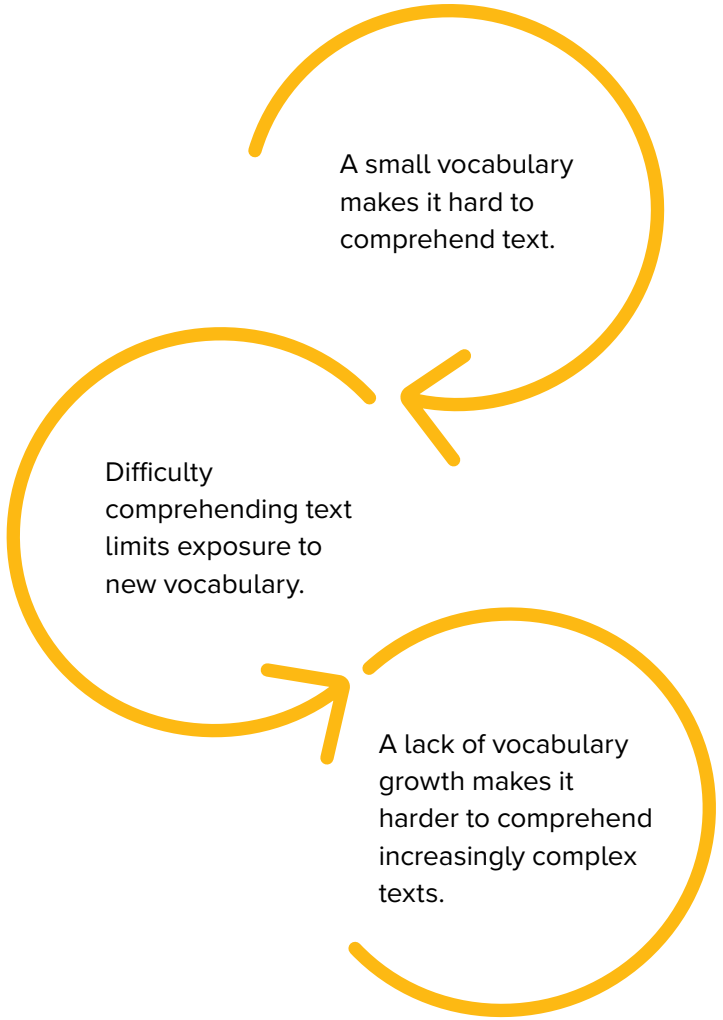
Vocabulary knowledge is a network that is constantly growing and changing.

This network connects word meanings, usage, and relationships with other words. It takes many exposures to words in various contexts to build a rich network.



A small vocabulary limits comprehension.

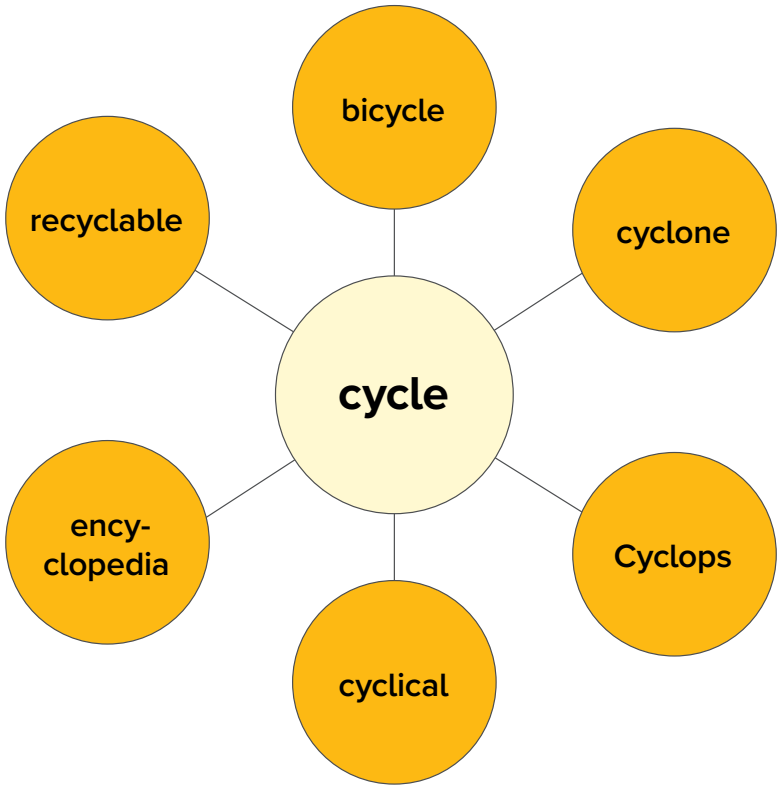
A combination of direct instruction—meanings, relationships, usage, morphology—and exposure to words in text and speech can grow a reading brain's vocabulary network.



(Stanovich, 2009)

Morphological awareness in particular accelerates vocabulary learning.

Morphemes—prefixes, suffixes, and roots—provide clues to meaning and grammar. Morphological analysis is an efficient strategy for the brain to learn a large number of new words in text based on a smaller set of morphemes.



Root word: *Cycle*

From the Greek word *kyklos*, meaning circle or wheel

Prefix example: *Re*cyclable

Re, meaning “again”

Suffix example: Recycl*able*

Able, meaning capable of being

Recyclable literally means “capable of being put through a cycle again”

To comprehend, the brain extracts meaning at two levels.

(Kintsch, 2012; Willingham, 2017)

Text-base level:
a mental model of the text's language.

Situation model level:
an overall interpretation of the text, integrated with the reader's knowledge.

Knowledge is critical for both levels of comprehension.

We study M-theory compactification on $\mathbb{T}^7/\mathbb{Z}_2^3$ in the presence of a seven-flux, metric fluxes, and KK monopoles. The effective four-dimensional supergravity has seven chiral multiplets whose couplings are specified by the G_2-structure of the internal manifold. We supplement the corresponding superpotential by a KKLT type nonperturbative exponential contribution for all, or for some of the seven moduli, and find a discrete set of supersymmetric Minkowski minima. We also study type IIA and type IIB string theory compactified on $\mathbb{T}^6/\mathbb{Z}_2^2$. In type IIA, we use a six-flux, geometric fluxes, and nonperturbative exponents. In type IIB theory, we use F and H fluxes, and nongeometric Q and P fluxes, corresponding to consistently gauged supergravity with certain embedding tensor components, *without nonperturbative exponents*. Also in these situations, we produce discrete Minkowski minima. Finally, to construct dS vacua starting from these Minkowski progenitors, we follow the procedure of mass production of dS vacua.

(Cribiori, Kallosh, Linde, & Roupec, 2020, p. 046018-1)

Adult reading brains might not notice the importance of knowledge until they read a text they can't understand—like this one on string theory.

Building knowledge is critical to reading comprehension.

(Davidson, 2023; Knowledge Matters Campaign, 2024)

To support students' academic language and conceptual understanding, high-quality, content-rich instruction should include:

- Close reading of content-rich, challenging texts through read alouds and repeated practice, both collaboratively and independently
- Systematic development of high-value academic language to support building knowledge
- Text sets organized around conceptually coherent texts to build knowledge
- Regular discussions grounded in texts and topics to build knowledge
- A volume of reading and writing to build knowledge
- Targeted supports to ensure all students have access to challenging grade-level content across the curriculum

Speaking and listening skills are the basis that reading and writing knowledge is built on.

Area of Language	Phonology *sound system*	Semantics *word meaning*	Morphology *word parts*	Syntax *sentence structure*	Pragmatics *social context*
speaking & listening	articulate & differentiate spoken words	higher frequency, concrete words	common prefixes & suffixes	simple, redundant, informal grammar	interaction with familiar social norms
reading & writing	map written letters to sounds	lower frequency, abstract words	Greek & Latin roots, prefixes, & suffixes	complex, dense, formal grammar	no interaction & social norms vary

Good writers make good readers.

Reading and writing are the receptive and productive sides of the same coin, and they reinforce one another (Graham & Hebert, 2010).

Students' reading abilities are improved by:

1. **Writing about the texts they have read**
2. **Explicit instruction in spelling and composition**
3. **Increasing length and frequency of writing**

The Strands That Are Woven Into Skilled Writing

(Sedita, 2019; Sedita, 2023)

Critical Thinking

- Generating ideas, gathering information
- Writing process: organizing, drafting, writing, revising

Syntax

- Grammar and syntactic awareness
- Sentence elaboration
- Punctuation

Text Structure

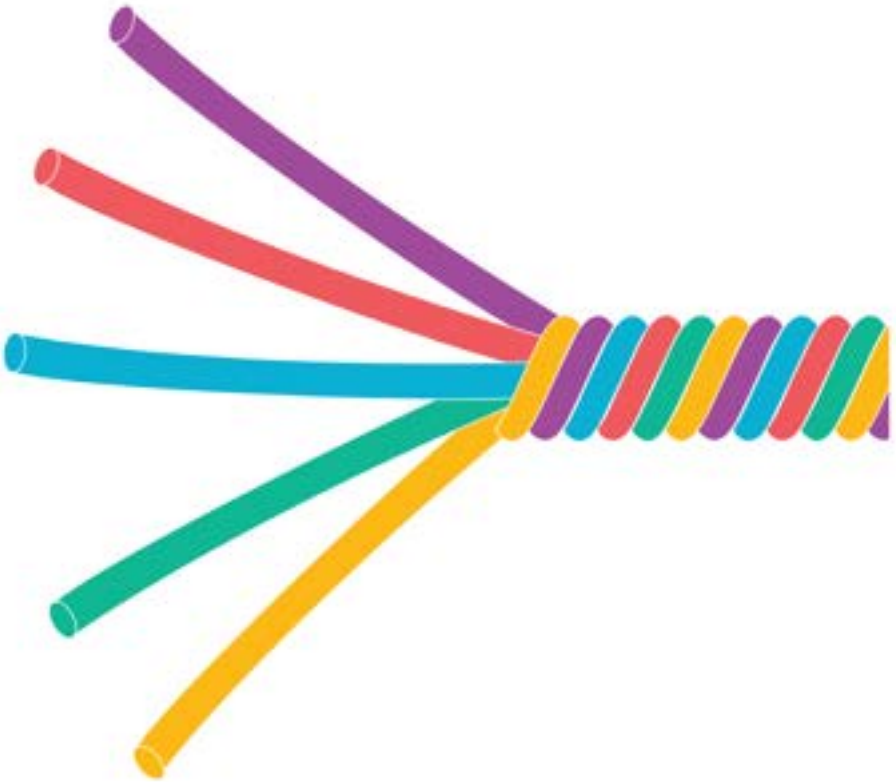
- Narrative, informational, opinion structures
- Paragraph structure
- Patterns of organization (description, sequence, cause/effect, compare/contrast, problem/solution)
- Linking and transition words/phrases

Writing Craft

- Word choice
- Awareness of task, audience, purpose
- Literary devices

Transcription

- Spelling
- Handwriting, keyboarding



Writing is an essential tool for learning.

A research-based approach for teaching writing should be deeply integrated with content learning (Hochman & Wexler, 2024), with a clear emphasis on:

Sentence-level work

Focus on constructing clear, grammatically correct sentences, through activities like sentence expansion, combining, and revision.

Structured scaffolding

Teach students how to write clear topic sentences, transitions, and conclusions, with scaffolded support through the use of templates and graphic organizers.

Explicit grammar and syntax instruction

Teach grammar in the context of writing, not in isolation, to help students learn how sentence structure affects meaning and clarity.

Frequent practice

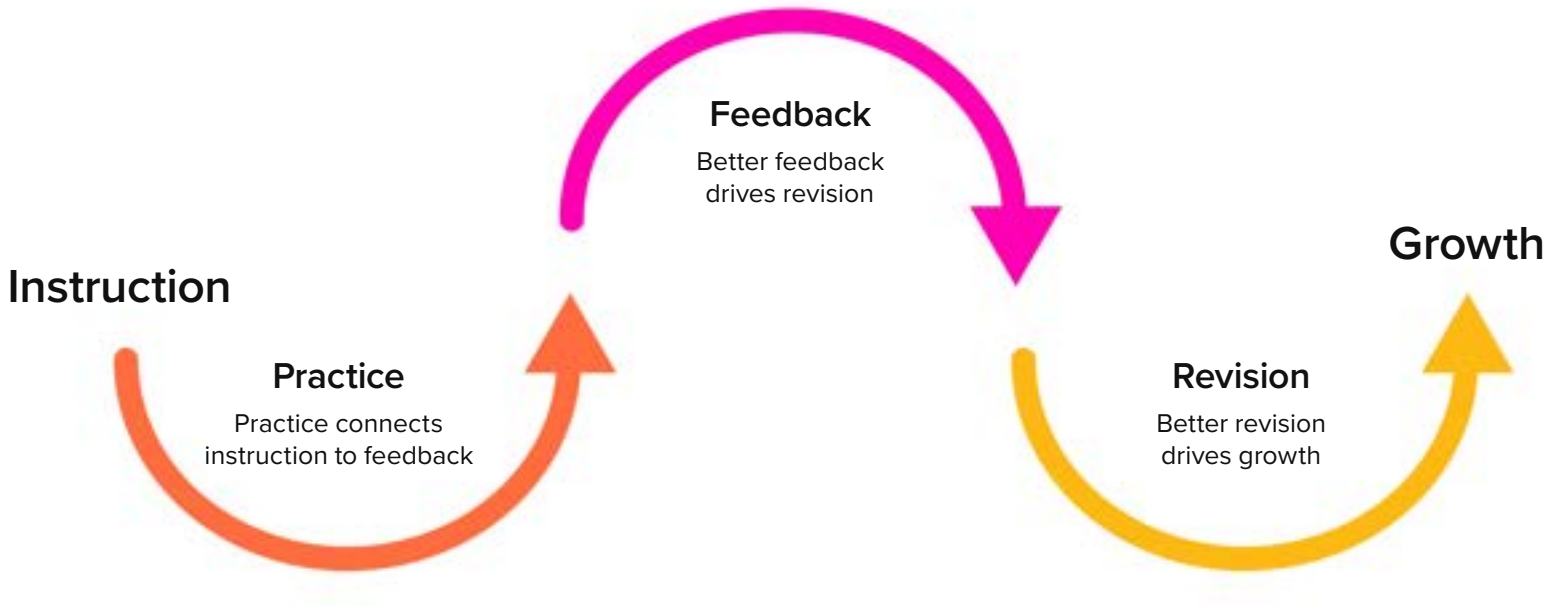
Practice writing daily, across subjects with an emphasis on short, frequent tasks, as well as longer written essays.

Content integration

Connect writing tasks to what students are learning in other subjects to reinforce comprehension and retention of academic content.

Student centered, growth-oriented approach to writing

Students must practice writing with adequate support and mentorship, including targeted feedback, which leads students to revise with intention, a key component of achieving growth and proficiency (Hicks, 2025).



Feedback enhances student writing proficiency

Better feedback inspires writers toward revision, and revision leads to improved writing (Hicks, 2025).

- Feedback should be targeted and aimed at meeting students where they are as writers, with the end goal of driving substantive revision.
- Feedback is most effective when it's connected to instruction, and put into context for students in a way that combines teacher-, peer-, and self-review.
- The act of reviewing helps students build metacognition that drives additional reflection of key writing skills and gains in proficiency; the act of being reviewed by an authentic audience drives purpose and a more successful push into high-quality revision.

Pathway to equity

How can we support all learners to be strong readers and writers?

It will take all of us!

The reading improvement system model

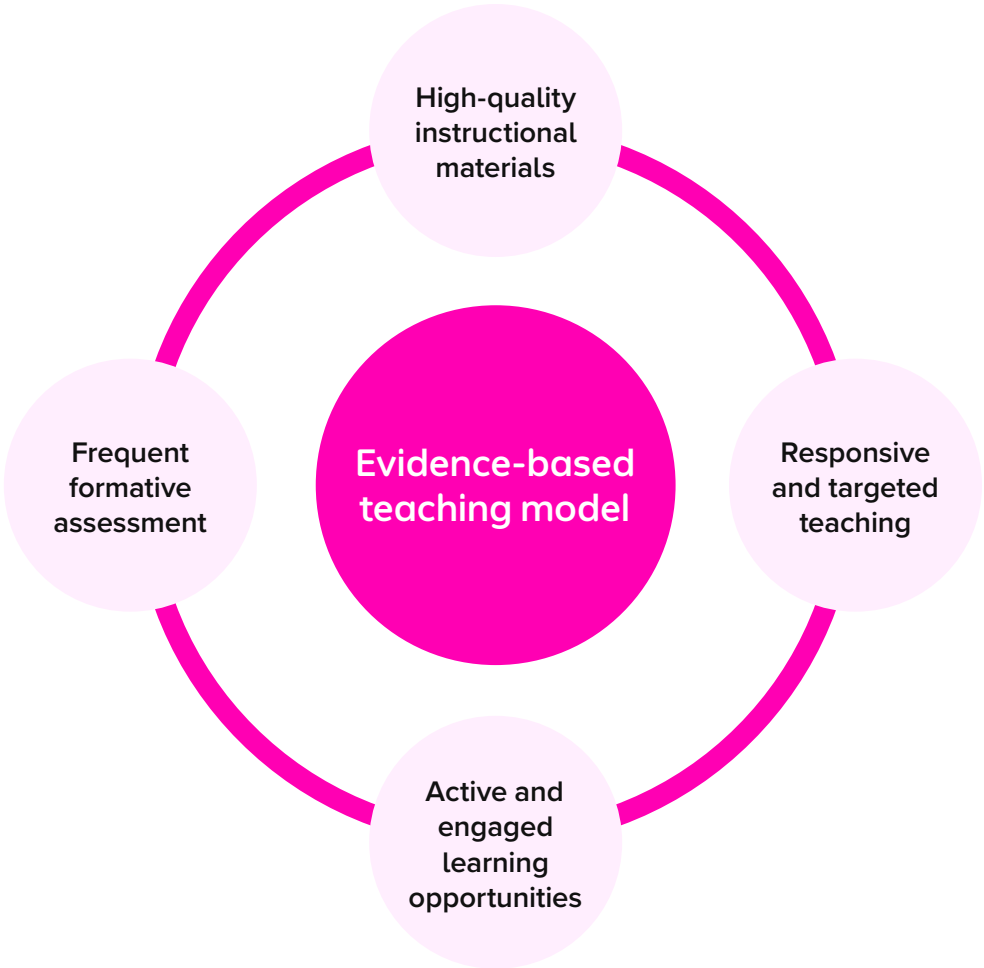
Reading Improvement System Model From Neuman, S. B., Quintero, E., & Reist, K. (2023). *Reading Reform Across America.* The Albert Shanker Institute. https://www.shankerinstitute.org/read

Reading is a cognitive process that is bolstered by positive learning habits and behaviors.

Learning to read is a challenging and effortful process that requires the capacity to persevere. Comprehending text requires active self-regulation, engagement, motivation, and perspective taking (Duckworth et al., 2007; Duke & Cartwright, 2021; Dweck, 2006).

When educators and families come together to support students, reading outcomes improve (Hughes & Kwok, 2007; Wolf, 2018).

While we know how to build a reading brain, each brain is unique.



The greatest gains happen within an evidence-based model in which teachers use high-quality instructional materials to responsively target skills and strategies, based on frequent formative assessment, ensuring students are ready to learn.

Professional learning to support student learning

Professional learning opportunities for teachers, coaches, and school leaders help excel student learning when it connects the Science of Reading with the schools' high-quality instructional materials. Professional learning should:

- Translate scientific evidence related to the essential elements of literacy—such as phonemic awareness, fluency, building knowledge, vocabulary, language, and reading comprehension—into practical applications
- Deepen understanding of Science of Reading high-impact instructional strategies and routines through actionable learning connected to teachers' ELA program resources

Contributors

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