Digital Promise Global

3 *in a series*

Making Learning Personal for All

Supporting Research-Based Personalization for Reading Success

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Overview

To meet the growth in learner diversity in today's classroom, a new paradigm for improving the precision and accuracy of "personalization" is critical to address the needs of students who are held back by traditional pathways designed for the mythical "average" learner.

In response to this challenge, Digital Promise Global has embarked on a multi-year initiative, Learner Positioning Systems™ (LPS). The culmination of two years of systematic literature review and framework development, the LPS website is a free, open-source digital resource presenting the research behind the Learner Factors ("Factors") that most impact learner variability. These Factors are the aspects of each of us that affect how we learn best, such as our working memory and social supports. The LPS app translates the Factor research into actionable educational product design and curriculum strategies for developers and educators to support research-based personalization for the full diversity of learners.

This paper provides an overview of the research behind LPS's first area of focus, K-3 Reading. Beginning with the common standards used to evaluate reading success, the paper then details each area of LPS's K-3 Reading research and identifies the specific Factors with links to full annotated bibliographies for each. Finally, this paper explores interactions among Factors to highlight the complexity inherent in each person's individual learning path. ■

Understanding the K-3 Reading Learner Model

The first research focus, or "Learner Model," in the LPS project focuses on the combination of Factors that influence how students learn to read. Reading comprehension is remarkably complicated and requires the rapid coordination of a complex set of processes, including:

Recognizing letters in a word and sounds formed by those combined letters;

Mapping the visual form of the written word to the stored meaning of that word in the brain;

Determining how a word fits into the structure of the sentence and how the sentence fits into the context of the passage; and

Integrating all of the information in the text with background knowledge to fully understand the meaning.

To try to understand what Factors underlie these many processes, the LPS research team used a multifaceted approach combining research from these different fields of learning science:

- Language and Literacy;
- Cognition;
- Social Emotional Learning (SEL); and
- Student Biographical Background.

Studies included in the research review used a wide variety of research methods, including studies conducted in schools and studies conducted in research laboratories using neuroimaging and computer-based experimental techniques. By reviewing studies across multiple research disciplines, the team captured a comprehensive view of the current literacy research. An advisory board of leading learning scientists and practitioners provides ongoing review to incorporate new research and suggestions for improvement in the Learner Model.

Using a rigorous selection process (described in detail here), **34 Factors were identified within the areas that current research shows as critical for K-3 reading development.**

K-3 Reading Development Factors

Select a factor to see annotated bibliographies at digitalpromise.org.

Language and Literacy	Cognition	Social Emotional Learning (SEL)	Student Background Information
Alphabet Knowledge	Attention	Emotion	Hearing
Background Knowledge	Auditory Processing	Motivation	Home Literacy Environment
Decoding	Inhibition	Self-Regulation	Physical Fitness
Morphological Awareness	Long-term Memory	Social Awareness and Relationship Skills	Primary Language
Narrative Skills	Sensory Integration		Safety – Physical & Mental
Phonological Awareness	Short-term Memory		Sleep
Print Awareness	Speed of Processing		Social Supports
Sight Recognition	Visual Processing		Socioeconomic Status (SES)
Syntax	Working Memory		Trauma
Verbal Reasoning			Vision
Vocabulary			

The LPS website contains a description of each Factor and its influence on reading, as well as which Factors interact with others to affect learning to read. These Factors are then linked to research-based instructional strategies that also provide guidance for product developers.

Through this synthesis of the current research, the LPS team hopes to help curriculum designers and edtech developers gain an even more complete picture of how each individual student learns essential reading skills.

For example, if a developer wants to create a product to improve Decoding skills, it is critical they also understand the Factors that affect Decoding, such as Working Memory and Phonological Awareness. Using LPS's suggested design features and strategies, they can develop features that support the variability across all of the skills needed for Decoding that is inherent in the full diversity of learners. ■

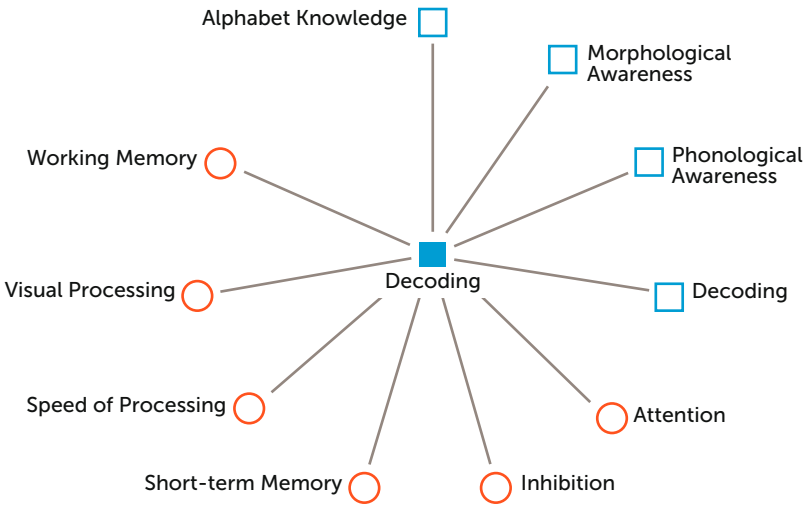
What Makes a Successful Reader?

Reading comprehension is the goal. When synthesizing the current literacy and learning science research, we focused on the path students take to become confident readers, from their early language experiences, through decoding and fluency, and ultimately to comprehension.

Children's early language experiences are an essential first step toward literacy. This exposure to oral language helps train the brain to process language quickly and efficiently, as well as helps build vocabulary. Children benefit when parents and caregivers provide rich language input by speaking to them frequently, using a wide vocabulary.[1] Children start to learn oral language through this early exposure, setting the stage for learning to read.[2]

Decoding is the bridge between oral language and reading. Decoding skills allow learners to sound out words by understanding how letters correspond to speech sounds. Decoding is particularly important when first learning to read because it allows students to correctly sound out the written forms of words so they can properly match the written word with words they know from their early language experiences.[3] Learners with good decoding skills will also be able to more easily sound out more complex and unfamiliar words and therefore can tackle more complex texts.

Decoding Factor Map



Eventually, readers with good decoding skills will advance from having to decode most words to easily recognizing many words by sight. This supports reading fluency –the ability to read quickly, accurately, and expressively. Fluent readers can rapidly read text with few mistakes while using correct intonation and stress (e.g., correctly using pitch to distinguish between a statement and a question).[4]

Once children become more fluent readers, they can focus more on reading comprehension than decoding.[5] Comprehension, or readers understanding the texts they read, is the goal of literacy education. Ultimately, students are able to incorporate their knowledge of vocabulary with their background knowledge to be able to infer and comprehend the complete

meaning of a text.[6] Reading comprehension then grows more complex as students are able to read increasingly sophisticated texts.

While this pathway from developing decoding abilities to comprehending complex texts has skills that follow one upon the other, it is not a simple linear process. Rather, this process can be conceptualized more as an interwoven lattice where language, literacy, cognitive, social, and other environmental factors all interact and develop in a reciprocal manner.[7] In this lattice, literacy skills support the development of social-cognitive skills and, in turn, social-cognitive skills support the growth of literacy skills. Initially, there is more emphasis on decoding, and as literacy and social-cognitive skills evolve, the emphasis becomes more focused on comprehension.

In this way, the skills that underlie early language experiences and lead to decoding, fluency, and comprehension are formed through intricate interactions among the different Factors in the research areas of literacy and language, cognition, SEL, and biographical background. We will now dive deeper into the current research within these four areas. ■

What Impacts a Learner's Path to Becoming a Confident Reader?

Despite advances in personalized learning in recent years, there is clearly more work to be done. Inherent in the concept of personalization is that we can only personalize based on what we know about learners.

Language and Literacy

In the current language and literacy research, an important distinction is made between oral language and text-based literacy skills. Humans have had the ability to communicate using spoken language for tens of thousands of years. However, only recently has the majority of the world's population become literate, with the worldwide literacy rate increasing from 12 percent in 1820[8] to over 80 percent today[9]. Additionally, children typically learn their native spoken language without formal instruction; however, explicit instruction is imperative for learning to read.

While spoken and written language skills can seem separate in this historical view, in reality, they influence one another in complicated ways. Through the LPS project, we have attempted to capture the many interactions that occur within this large research area.

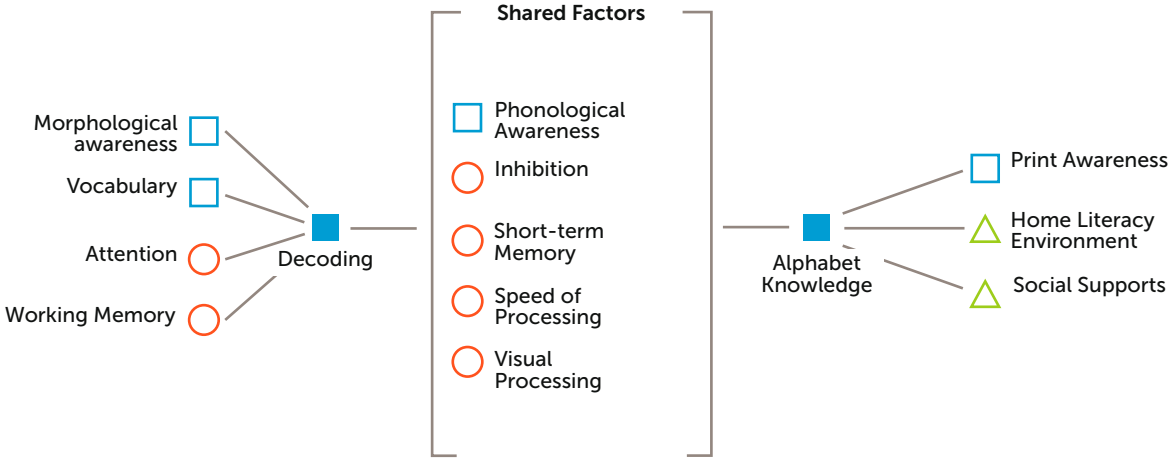
We identified seven major oral language Factors that contribute to children's ability to comprehend and produce spoken language, and four major text-based Factors.

Language and Literacy Factors

Select a factor to see annotated bibliographies at digitalpromise.org.

Oral Language Factors	Text-based Factors
Background Knowledge	Alphabet Knowledge
Morphological Awareness	Decoding
Narrative Skills	Print Awareness
Phonological Awareness	Sight Recognition
Syntax	
Verbal Reasoning	
Vocabulary	

Connections between Decoding and Alphabet Knowledge



As briefly discussed above, one of the most influential Factors impacting language and literacy is Decoding, or the ability to properly sound out words by applying knowledge of relationships between letters and speech sounds. Decoding and its counterpart encoding (or spelling) also include understanding letter patterns that form certain syllables and sounds (e.g., the letter "c" can indicate a /k/ sound in "cat" or an /s/ sound in "mice").

Thus, strong Decoding skills rely on both Alphabet Knowledge (being able to recognize letters of the alphabet) and Phonological Awareness (knowledge of and ability to manipulate the smallest units of sounds in speech, such as /r/ and /l/), as well as the rules about how letters and sound connect (phonics). When students develop strong Decoding skills, they are able to read increasingly complex words, which leads to better fluency and comprehension.

Cognition

Cognitive skills are fundamental brain-based processes that make it possible for us to perceive information in our environment; pay attention to the environment while ignoring irrelevant information; store information in our brain to be recalled at a later time; and reason and think.

These basic cognitive abilities support the development of the language and literacy skills that allow us to learn language and how to read.

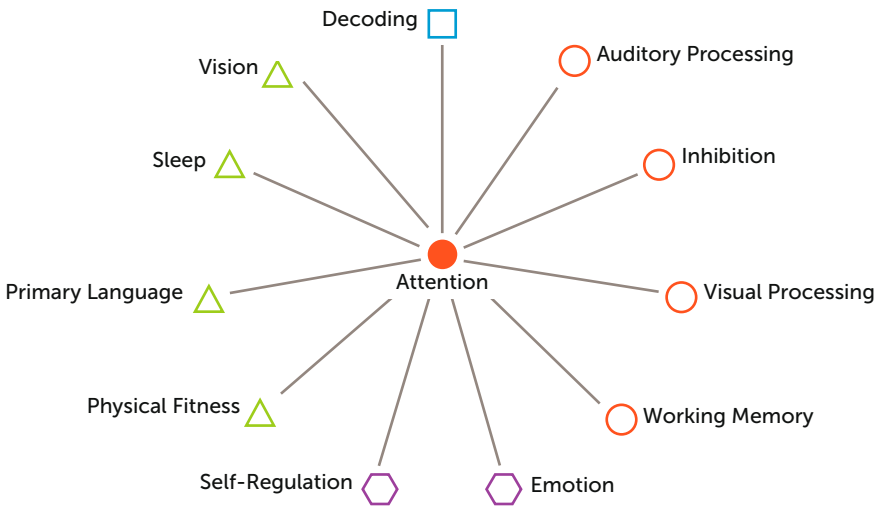
Based on currently available research, **we identified nine major cognitive Factors essential to K-3 Reading.**

Major Cognitive Factors

Select a factor to see annotated bibliographies at digitalpromise.org.

Attention	Long-term Memory	Speed of Processing
Auditory Processing	Sensory Integration	Visual Processing
Inhibition	Short-term Memory	Working Memory

Attention Factor Map



Attention skills are extremely important for learning to read because they help students focus on classroom activities and lessons. Attention is the ability to focus on important information in the environment. Inhibition, another cognitive Factor, supports Attention processes by helping students inhibit irrelevant information in the environment, such as the slight flicker of fluorescent lights or another student talking behind them. Inhibiting superfluous stimuli helps students concentrate on learning classroom lessons on reading and thoroughly comprehending text.

Attention skills can vary widely among students. Some students can attend to classroom material for extended periods of time, while others have attention difficulties. Understanding the research about the underlying learner differences in Attention can help developers and educators personalize for students' individual needs to help each student achieve their full potential in the classroom.

Social Emotional Learning

Social emotional learning (SEL) involves both acquiring and applying knowledge about emotions. This then helps students learn to establish and maintain positive relationships with others by managing their own emotions and understanding how their behavior can impact the feelings of others. **We identified four SEL Factors with the biggest impact on K-3 Reading based on currently available literature.**

Social Emotional Learning Factors

Select a factor to see annotated bibliographies at digitalpromise.org.

Emotion

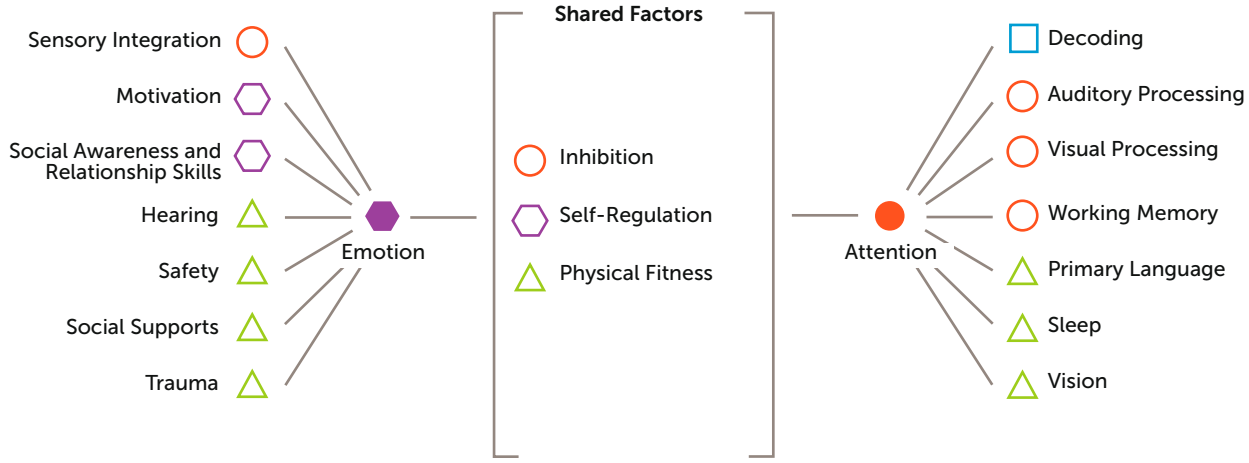
Motivation

Self-Regulation

Social Awareness and Relationship Skills

Research has shown that implementing specific SEL curricula can help students develop stronger SEL skills that also improve academic performance, including learning to read.[10] Students with strong SEL skills often have improved attitudes, encounter less emotional distress, and display fewer conduct problems.[11] Better SEL skills also can help students understand and manage emotions and resulting behaviors so they can focus better in school.

Connections between Emotion and Attention



Research shows that Emotion is one of the most important SEL factors for K-3 readers.[12] Emotions are complex psychological states that result in physiological and psychological changes that influence behavior. Emotions can be positive, negative, or a mix of both. Students who have Emotional competence can identify and express their own Emotions and other people's Emotions and understand the consequences of Emotions.

Students may experience positive or negative Emotions that are tied to reading or to being in a classroom environment. For example, students who have reading anxiety find it difficult to focus on reading materials, which negatively impacts comprehension.[13] In contrast, when students read Emotionally compelling materials, this can help enhance their Attention skills, positively impacting comprehension.[14]

Student Biographical Background

Many aspects of a student's background can influence language and literacy, cognitive, and SEL Factors. **We identified ten important student biographical background Factors that should be considered when personalizing learning.**

These Factors include different aspects of a student's physical well-being, as well as the environment in which the child is raised. For example, research demonstrates that being raised in a Safe environment; free of emotional

Student Biographical Background Factors

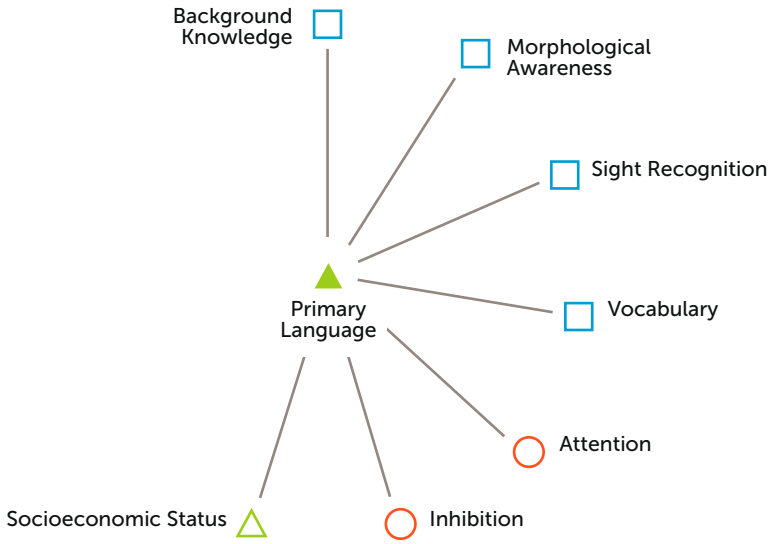
Select a factor to see annotated bibliographies at digitalpromise.org.

- Hearing
- Home Literacy Environment
- Physical Fitness
- Primary Language
- Safety – Physical & Mental
- Sleep
- Social Supports
- Socioeconomic Status (SES)
- Trauma
- Vision

distress and Trauma;[16] and with Social Supports from family, school, community, and friends[17] helps children thrive in school, including learning to read. Children who are raised in challenging environments will require additional supports to help them thrive in the classroom.

Furthermore students whose early literacy skills are nurtured by caregivers who read to them and provide ample access to reading materials before they enter school (e.g. children raised in a rich Home Literacy Environment) will more easily develop fundamental literacy skills once they enter kindergarten.[18]

Primary Language Factor Map



Another biographical Factor important to literacy development is a student's Primary Language – the language they have been exposed to from birth. Students whose Primary Language is different from their school's language have a unique profile that distinguishes them from their monolingual peers. Students who learn more than one language often have Cognitive advantages and will also often have more job opportunities and other advantages in the future.[19]

However, because they are learning multiple languages, they also typically acquire knowledge of Vocabulary and Syntax (i.e., grammar) in each language more slowly than children who know only one language.[20] With language and literacy support at home and in school, they can match and even surpass their monolingual peers. ■

Exploring the Interactions among these Critical Factors

The previous sections described one Factor within each research area: Decoding (language and literacy), Attention (cognition), Emotion (SEL), and Primary Language (student biographical background). To briefly highlight how Factors across these four areas can impact and influence one another, this section explores the complex interactions between these four Factors.

First, students with good Emotional regulation skills are better able to manage their feelings, which leads to better Self-Regulation of their behaviors.[21] When children are better able to control their Emotions and behaviors, they can focus their energy on paying Attention to classroom lessons. This in turn helps children develop early literacy skills because research has shown that students with lower Attention skills have difficulty concentrating on classroom lessons, which means they will often struggle to learn skills such as Alphabet Knowledge and Phonological Awareness, both important for Decoding.[22] Because Decoding is an essential initial step to reading fluency and comprehension, the combination of Emotional regulation and Attention skills can directly impact how well a student will learn to read.

Primary Language also interacts with these factors. Bilingual/multilingual children tend to have better Selective Attention (the ability to select and focus on pertinent information while ignoring irrelevant stimuli) than monolingual children.[23] Yet, bilingual/multilingual children attending a school that teaches in a language other than their Primary Language will initially gain early literacy skills like Alphabet Knowledge more slowly than monolingual peers.

Thus, although bilingual/multilingual children develop some cognitive advantages, they will initially have difficulty learning to Decode a language that is not their Primary Language. Supporting these unique learners based on their specific needs will help them achieve the strongest reading skills possible.

Factor interactions can also shed light on formally diagnosed learning issues. Some students have variability that is categorized as developmental dyslexia, a reading difference that makes it hard for them to accurately Decode words due to difficulty discriminating letters and their corresponding sounds from one another. For example, many children with developmental dyslexia have difficulty discriminating among the individual sounds in words and blending sounds together to create meaningful words (b - a - t = bat). While the exact underlying cause of developmental dyslexia is still unknown, research suggests variability in brain structure[24] and instruction likely contribute to difficulties with Decoding,[25] and research has also indicated that difficulties with Phonological processing (an oral language Factor) are implicated in dyslexia.

Even within the the group of children categorized as having developmental dyslexia, individual variability is prevalent. Yet, efficient tools to help understand early strengths and weaknesses across these different Factors that underlie developmental dyslexia are not readily available in school classrooms. However, if developers and educators understand the research behind the different Factors critical to reading success, they can then personalize tools and curriculum to best support students based on their individual learner needs. ■

Ongoing Research to Support All Areas of Learning

As part the LPS project, LPS researchers will continue to review the K-3 reading literature across each of these four research areas to ensure the most recent research is incorporated into the K-3 Reading Learner Model. We anticipate that the ongoing research review and new research by learning scientists will lead to the identification of additional Factors that we will add to the Model.

We also are engaging with people using the K-3 Reading Model for product design and curriculum development to help increase awareness of the myriad Factors that can impact literacy learning, as well as to build supports and products to address the vastly unique needs of each individual student.

We also plan to conduct research on whether and how product design and strategies based on these Factors impact learning trajectories to help develop new tools and strategies to best support learners.

In the meantime, we are expanding the LPS project to encompass other learning areas where personalization can benefit students. We are currently developing an early elementary Math Model, and we will continue expanding across other academic subjects and ages.

Ultimately, we will build LPS Learner Models across all ages and content areas to uncover what research tells us we should personalize in order to support the full diversity of learners.

To learn more about Learner Positioning Systems and to explore Learner Factors and the strategies to support them, visit lps.digitalpromiseglobal.org and request a password to access the site. ■

Endnotes

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