My Reading Academy: An Adaptive, Game-Based Solution to Forming the Building Blocks for Reading Success

Executive Summary

Early literacy skills are critical building blocks for academic and life success. While some children enter school with most of these building blocks in place, others struggle to learn reading from the start and remain behind their peers throughout formal schooling. These issues of learner variability are intensified by multiple factors, including the diversity of infant and toddler experiences, the complexity of reading behaviors, and the capacity of teachers and instructional resources to meet the needs of vastly different learners. With the incomplete learning that has affected many children throughout the pandemic, providing learners with high-quality early reading instruction and parents and teachers with the tools needed to support them is essential.

My Reading Academy is a comprehensive, adaptive learning solution that provides a personalized path to learning to read through games, books, and videos. Grounded in the science of reading, *My Reading Academy* guides children ages 4–8 through explicit and systematic phonemic awareness and phonics instruction that is paired with rich reading and language experiences. Using current research and an understanding of playful engagement and educational games, the team at Age of Learning, Inc., developed *My Reading Academy* to provide more than 20 compelling games that address over 500 Learning Objectives. *My Reading Academy* uses a mastery-learning approach to deliver differentiated instruction, appropriate scaffolding, and feedback to ensure that every learner masters each skill as they advance through the system.

My Reading Academy Was Designed to Be the Following:

- **Research-Driven:** Grounded in the science of reading, *My Reading Academy* was designed to deliver comprehensive instruction based on best practices in early literacy and cognitive development research.
- **Adaptive:** *My Reading Academy* fosters multiple learning trajectories through adaptive and formative assessments.
- **Engaging:** Short bursts of instruction and formative feedback are delivered by charming digital “friends”; purposeful practice is presented in fun game formats; and immersive reading experiences cultivate a love of reading.
- **Empowering:** Through our Personalized Mastery Learning Ecosystem™ (PMLE™), we provide real-time actionable data for teachers and administrators as well as instructional resources and at-home activities for families and caregivers.
- Teachers have found *My Reading Academy* to be a resource that allows them to provide individualized, differentiated instruction.

The Reading Landscape

Learning to read is a fundamental skill necessary for academic and life success (Murnane et al., 2012). Early reading ability not only has significant implications for academic success within and beyond reading (e.g., La Paro & Pianta, 2000; Purpura et al., 2011; Whitehurst & Lonigan, 1998), but it also predicts success in communication and motivation. Children who enter school with foundational literacy skills have richer vocabularies that help them express themselves in their interactions with others. Moreover, they are more likely to start school with a readiness to learn and an enthusiasm for reading that can persist throughout formal schooling (Hanson & Farrell, 1995). Early literacy is also linked with socioemotional capabilities, as it can support behavior regulation, problem-solving, creativity, and empathy in children's interactions with others (McClelland et al., 2007; Miles & Stipek, 2006; Snow et al., 1998). Indeed, those with a solid early reading foundation start school prepared with a skill set that boosts their success across domains.

For some children, learning to read can be a difficult and lengthy process. As many as one third of young children may experience struggles in learning to read (Adams, 1990; Amplify, 2021). These struggles can have many different causes stemming from opportunity gaps, including cognitive or neurobiological differences, learning English as a second language, and limited support from teachers in the classroom and parents at home (Baker, 2003; Snow et al., 1998; Taylor & Ysseldyke, 2007). They often result from unresolved reading difficulties and are present across ethnic, gender, native language, and socioeconomic groups (Chatterji, 2006; Snow et al., 1998; U.S. Department of Education, 2007). Furthermore, these struggles persist over time: Many children start behind their peers in reading before entering school and lag farther behind long after formal school entry (Foster & Miller, 2007; Scammacca et al., 2020; Stanovich, 1986).

Moreover, teachers often lack the resources, background, and bandwidth to ensure that all their students acquire the essential skills and strategies they need to read. Teachers must juggle the mandate to address grade-level standards with the reality of addressing the unique needs of each child, such as those who may have learning disabilities, behavioral issues, or other difficulties that can impede learning. They may also lack the necessary training to teach both striving learners and those who do not respond to traditional early literacy instruction (Otaiba & Fuchs, 2006). Struggling in reading is not uncommon. Fewer than 40% of U.S.

students demonstrate proficiency in reading by the time they reach 4th grade (U.S. Department of Education, 2019). Critically, the COVID-19 pandemic has further challenged teachers in their jobs, as disruptions and learning loss contribute to reading knowledge gaps (Kuhfeld et al., 2020; Pier et al., 2021). In brief, it is challenging, now more than ever, for teachers to help all students successfully learn to read.

My Reading Academy is one solution to the roadblocks children and educators encounter on the path to reading success. It is a scalable, engaging solution for addressing learner variability that empowers parents and teachers with tools and resources to support their children as they learn to read for the first time. Developed by an interdisciplinary team of learning scientists, curriculum experts, data scientists, design researchers, efficacy researchers, and game designers at Age of Learning, the program teaches children ages 4–8—the most critical years for reading intervention (Torgesen, 2005)—the foundational skills necessary for reading. Using a research-driven design process, each Learning Activity is tested with children, data is gathered and analyzed, insights are developed, and changes are made in an iterative process that continuously improves the program's effectiveness on children's early reading abilities. The result is a mastery-based, adaptive, game-based digital program that delivers systematic instruction through instructional videos, learning games, and reading experiences designed to engage children in their own individual processes of learning to read. In sum, *My Reading Academy* is (1) research-driven, (2) adaptive, (3) engaging for children, and (4) empowering for parents and teachers in helping children learn to read.

Research-Driven

My Reading Academy's Reading Instruction Is Grounded in the Science of Reading

First, *My Reading Academy* is research-driven. It's grounded in the science of reading, leveraging decades of seminal research across literacy education and cognitive development in its curriculum.

Simple View of Reading

In their seminal work, *The Simple View of Reading,* Gough and Tunmer (1986) argued that both decoding words and comprehending language are necessary for skilled reading, in response to the belief held by some that decoding is unnecessary to learn. In their view, learning to read requires developing the ability to recognize and decode words, as well as the ability to take lexical and semantic information about a word to make interpretations about a sentence. If a reader cannot decode the letters and words, they will be unable to read and understand that word. Therefore, both skills need to be taught in tandem to develop strong reading comprehension.

In the *Rope Model of Reading*, Scarborough (2001) represents skilled reading as a rope through which many foundational skills are woven. While this model of reading is also intended to be simple, it describes the nuanced blending of several distinct components. Elements of word reading (e.g., phonological awareness, phonics skills, and sight word recognition) work together with increasing automaticity to create one multifaceted part of the rope. Each of the language comprehension elements (e.g., background knowledge, text knowledge, comprehension monitoring, vocabulary knowledge, and language skills) reinforce one another for the second strand of the rope. These two coiled strands of rope represent the spiraling and intertwined nature of word reading and language comprehension over time. Readers become increasingly strategic and sophisticated in their use of language comprehension elements. The word-reading braid and language-comprehension coil are woven together to form the complex "rope" of reading. In brief, the rope is made up of many essential and interdependent skills; failing to learn even one of these skills can cause children to struggle when learning to read.

How We Learn to Decode Words

To read words, a child must master the *alphabetic principle*, the concept that there is a direct correspondence between sounds and letters. According to *Phases of Word-Reading Development* (Ehri, 1995; Ehri & Snowling, 2004), children develop along a continuum that progresses from not knowing that letters represent sounds to gaining letter and sound knowledge to being able to recognize and sound out words. Therefore, reading starts with recognizing and decoding words (Snowling & Hulme, 2011).

This process of turning unfamiliar words into accessible sight words is *orthographic mapping* (Ehri, 2014), that is, the process of forming letter-sound relationships and using this knowledge for spelling, pronunciation, and storing words in long-term memory. The first step in orthographic mapping is learning letters, sounds, and their relationships (Ehri, 2014). Building on these relationships, readers use phonic decoding to sound out and identify unfamiliar words. Learning how to use phonic decoding can lead them to learning how to detect, blend, and manipulate letters, sounds, and syllables into words (International Literacy Association, 2019). With practice and repetition, children map the letters of words to the sounds they represent, gradually building a bank of sight words that can be retrieved from long-term memory in future encounters (known as their *orthographic lexicon*). When children acquire orthographic mapping and can read words accurately and effortlessly, these words are then stored in their orthographic lexicon. As children solidify their understanding of letter-sound correspondences, they strengthen their ability to read words and phrases fluently (Castles et al., 2008). Orthographic mapping also explains how children learn to recognize words by sight, spell words from memory, and acquire vocabulary words from print (Ehri, 2014).

After decoding and high-frequency words are established, more attention can be devoted to comprehension, with a focus on making meaning (Castles et al., 2008). Although phonics instruction often ends after teaching letters and basic spelling, word recognition and orthographic mapping remain necessary lifelong skills (Young, 2018).

Essential Components of Reading Instruction

To understand and summarize existing research on reading, the National Reading Panel (National Institute of Child Health and Development [NICHD], 2000) reviewed several hundred empirical studies (out of more than 100,000 articles published since 1966) and conducted regional public hearings to identify “The Big Five” essential components of learning to read: phonemic awareness (identifying sounds and their articulatory features), phonics (identifying letter–sound correspondences), vocabulary (understanding words and meanings), fluency (reading with speed, accuracy, and expression), and comprehension (understanding a text; see Figure 1).

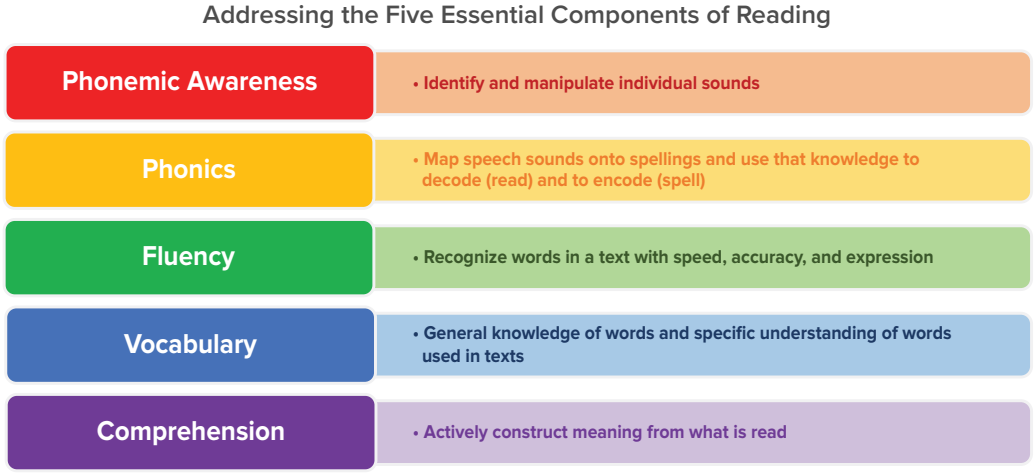


Figure 1. *My Reading Academy* aligns with the science of reading and reading instruction.

The Big Five are the essential components of effective reading instruction that contribute to reading success. Research has identified phonemic awareness as the strongest predictor of early reading success (Goodman et al., 2010; Wagner & Torgesen, 1987). Comprehension is considered the ultimate goal of reading (Petscher et al., 2020). Phonics, fluency, and vocabulary are essential to achieving phonemic awareness and comprehension. The National Reading Panel (NICHD, 2000) concluded that each component should be incorporated into instructional practices and suggested several techniques for effective instruction, including using computerized activities to teach reading. Research has also shown that effective instruction must include explicit and clear instructions (Archer & Hughes, 2011; Pearson & Gallagher, 1983) and must be systematic in the scope and sequence of activities (NICHD, 2000). Early reading instruction focuses largely on teaching children to map letters and spellings to the sounds of spoken language that the letters represent (Hanford, 2018; Snow et al., 1998).

Translating the Science of Reading into Learning Experiences

My Reading Academy's curriculum and activities were informed by an extensive analysis of state and national standards frameworks (e.g., Common Core State Standards) and literature on reading interventions, including The Big Five (NICHD, 2000). Based on this research, we developed a proprietary Knowledge Map of granular, measurable Learning Objectives and pathways toward learning to read. The Knowledge Map supplements a traditional phonics scope and sequence because *My Reading Academy* addresses multiple sequences of concepts and skills involved in word recognition and reading comprehension (see Figure 2).

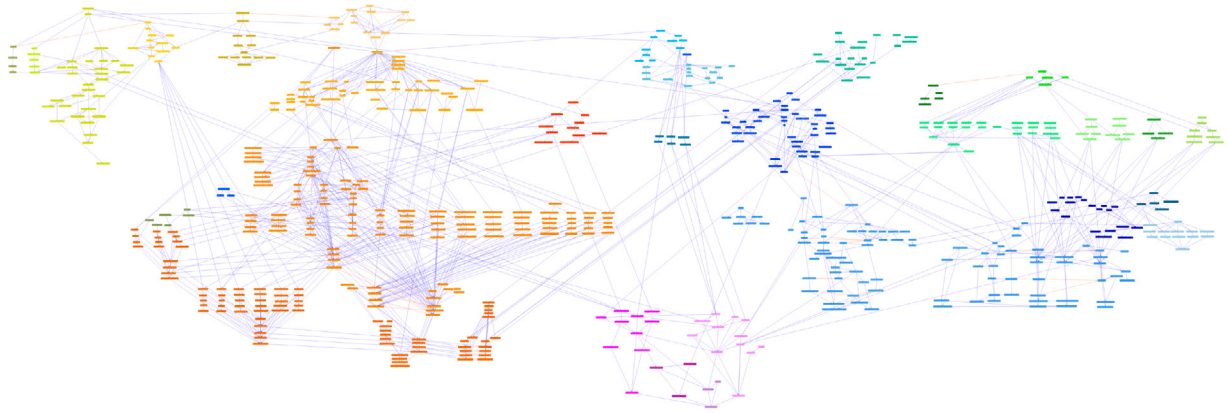


Figure 2. *My Reading Academy*'s Knowledge Map overview of pre-K through 2nd grade word recognition and language comprehension. Each rectangle represents a Learning Objective. Colors represent different skills and knowledge based on the science of reading. Lines represent connections and possible learning trajectories between Learning Objectives.

Each Learning Objective is mapped to create a connected model of reading knowledge and skills. The *My Reading Academy* Knowledge Map represents all possible learning trajectories, and this nonlinearity provides the blueprint for creating flexible Learning Paths that are responsive to each child's individual strengths and needs. Thus, the Knowledge Map organizes the science of reading into a dynamic web of knowledge. This mapping allows *My Reading Academy* to accommodate learner variability by determining what children know and deciding what they are most ready to learn next, based on this knowledge.

After identifying the elements of reading and creating hypothetical learning trajectories, the team at Age of Learning used the resulting structure of knowledge and skills to build a dynamic set of learning experiences. To address all Learning Objectives, we used an approach based on evidence-centered design (Mislevy et al., 2003; Mislevy et al., 2014) to translate the Knowledge Map into a collection of games, videos, and reading experiences that engage children in activities that generate evidence of reading skills and knowledge. Each game directly addresses a particular Learning Objective (e.g., the letter and sound of "m") to ensure that learning claims can be made based on each child's in-game behaviors. To measure progress, each game includes embedded game-based assessments that gather granular data about knowledge, skills, and abilities (Owen & Hughes, 2019; Shute & Kim, 2014). In sum, *My Reading Academy* can track learner progress across games and Learning Objectives through formative assessments.

Engaging Children

My Reading Academy is a personalized reading system of games, books, and videos designed to develop a child's mastery of word-reading and decoding skills, while simultaneously building strategies for strong comprehension.

Our approach to reading instruction fosters learning through *play*, where children interact with dynamic learning materials in order to master Learning Objectives. Play is essential in children's learning and development (Dietze & Kashin, 2011; Fisher et al., 2013; Fisher et al., 2011; Golinkoff et al., 2004). It's the mechanism for learning in games, allowing children the opportunity to explore action and meaning in liberating ways (Barab et al., 2005). Each learner has roles, goals, and agency, and their interactions drive learning progression (Squire, 2011). *My Reading Academy*'s games engage children in activities and stories contextualizing phonics learning within meaningful problem-solving situations. Children then play the game and receive immediate, specific, and understandable feedback, correctives, and scaffolding based on their decisions in the activity, which help reinforce learning and address misunderstandings immediately. Children learn more effectively when this feedback is accompanied by targeted instruction that addresses underlying misconceptions (Guskey, 1997). *My Reading Academy* leverages games to promote playful engagement, contextual learning, and embedded assessment.

By the Numbers

Within its personalized, adaptive system for teaching children to read, *My Reading Academy* includes

- more than 20 games, with over 650 levels;
- 150 books;
- 500 Learning Objectives; and
- 900 connections between Learning Objectives.

The Learner Experience in My Reading Academy

My Reading Academy applies the science of reading to support children in becoming fluent readers through instructional videos, skill-building games, and reading experiences.

Instructional Videos

Each game or reading experience starts with direct instruction on the Learning Objectives that are aligned to the activity. The instructional videos serve two purposes. First, the videos provide explicit instruction on the content, skills, and reading behaviors practiced in each game and book. (see Figure 3).

Figure 3. Miracle, the teaching video host, points out the letters of a word.

Second, the videos model the teacher and learner relationship. When children start *My Reading Academy*, they are greeted with a surprise package containing books, games, and a robot named Bitsy, who needs their help in learning to read. Children learn reading skills by interacting with a live-action host and teacher, Miracle, and a digital enthusiastic learner, Nano the Robot (see Figure 4). In *My Reading Academy*, children can inhabit multiple observer, participant, and teacher roles. This aspirational pair models fundamental learner social behaviors, such as asking questions and learning from mistakes.

Figure 4. Miracle and Nano collaborate.

The goal is for children to learn from Miracle and Nano so they can teach Bitsy, which builds on the work of Chase and colleagues (2009) that states children will have an increased and vested interest in learning, if they are also charged with the responsibility of teaching others (see Figure 5).

Figure 5. The *My Reading Academy* hub is where children choose activities with Bitsy, who is celebrating. In this learning-by-teaching model, the child has an added layer of motivation to learn the material, not only for themselves, but also to teach their robot. Teaching others allows the child to reflect on what they know and provides opportunities to share and explain these ideas. Children can feel a sense of accomplishment and pride when they teach Bitsy new skills and knowledge.

Building Reading Skills Through Games

Instead of a traditional scope and sequence, *My Reading Academy* is driven by a Knowledge Map that links Learning Objectives based on their relationships to each other and their role in the skill of reading. Building on the Rope Model, *My Reading Academy* incorporates the idea that reading skills and knowledge are interconnected, rather than isolated concepts. Skill-building games provide repeated, scaffolded practice with corrective feedback. Children learn and practice word recognition and comprehension through activities that offer structured, repeated practice and corrective feedback, leading to accuracy and automaticity with phonemic awareness and phonics skills. Rich reading and language experiences provide modeling, direct instruction, and guided practice to build fluency, vocabulary, and comprehension strategies.

My Reading Academy follows the research-based progression for effective literacy instruction (Castles et al., 2008; International Literacy Association, 2019). Children progress through a series of multilevel, adaptive games with different content and more profound skill development (see Figure 6). For example, children build spelling-sound correspondence skills by playing Sound Slider. Before progressing to letter identification and familiarization, children play a series of phoneme segmenting, blending, and substitution games. As children build skills in these areas, they also work on learning to recognize high-frequency sight words in Twirly Words. After practicing decoding and building knowledge of common words, children engage in choral and echo reading in Read with Nano! and sentence building in The Sentence Show.

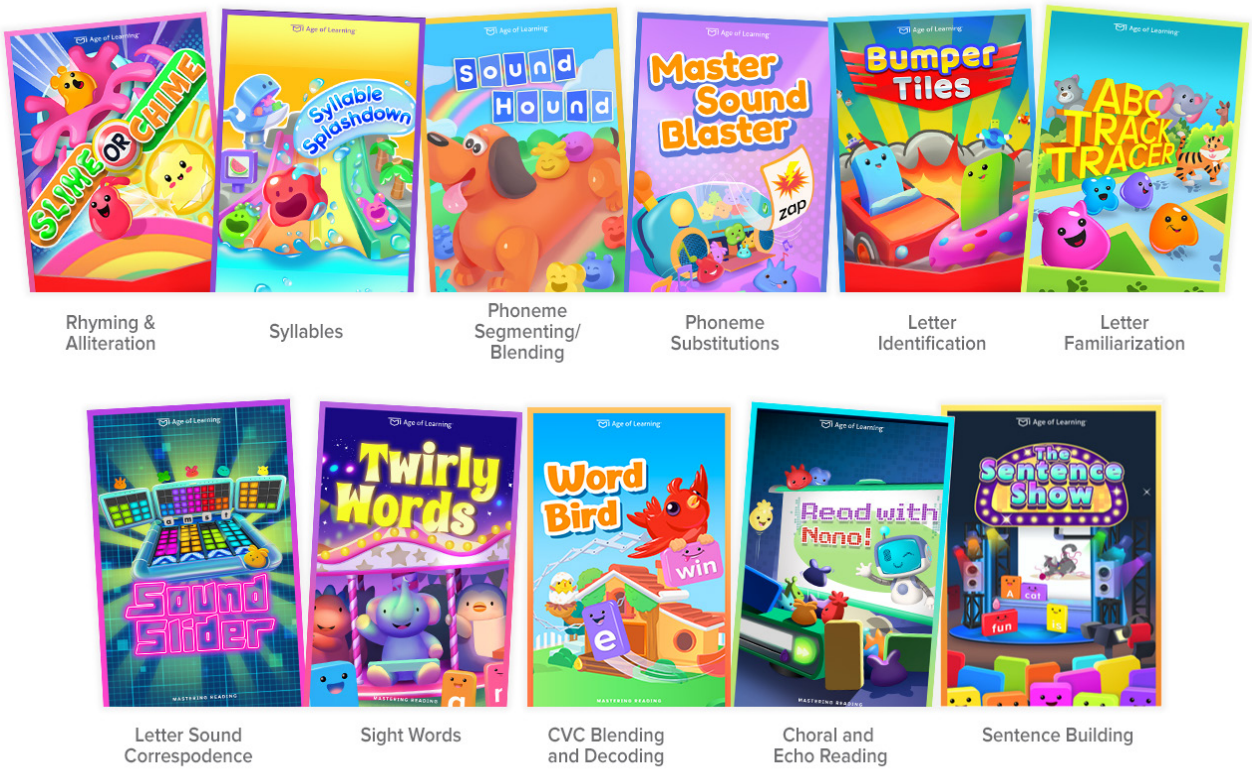


Figure 6. A sample game progression in *My Reading Academy*

Each game provides purposeful practice with corrective feedback that leads to accuracy and automaticity. Reading skills are then practiced within and across the games. Initial levels include substantial support and modeling to help the learner understand a concept through staged levels of corrective responses. For example, in one activity, learners get the prompt “rest” and need to choose from four letters and fill in the blank where the letter *s* is:

> **Child**: (chooses an incorrect letter)
>
> **Feedback**: “Oops, try again.”
>
> **Child**: (chooses an incorrect letter again)
>
> **Feedback**: “Try this strategy. Listen to the sounds in this word: /rrreeessst/”
> [the word “rest” is slowly said aloud]
>
> **Child**: (chooses an incorrect letter a third time)
>
> **Feedback**: “Let me show you. Listen: /r/, /e/, /s/, /t/. The missing letter is ‘s.’”

In the game’s final level, children demonstrate mastery by completing tasks without these scaffolds.

Orthographic Mapping

My Reading Academy facilitates word recognition by providing virtual manipulatives (e.g., Letter Tiles, Blurts, and Word Tiles) that systematically teach and reinforce letter-sound relationships using tiles and Blurts (see Figure 7). These manipulatives serve as building blocks and are iteratively combined with sequences of skill instruction videos and playful practice in games.

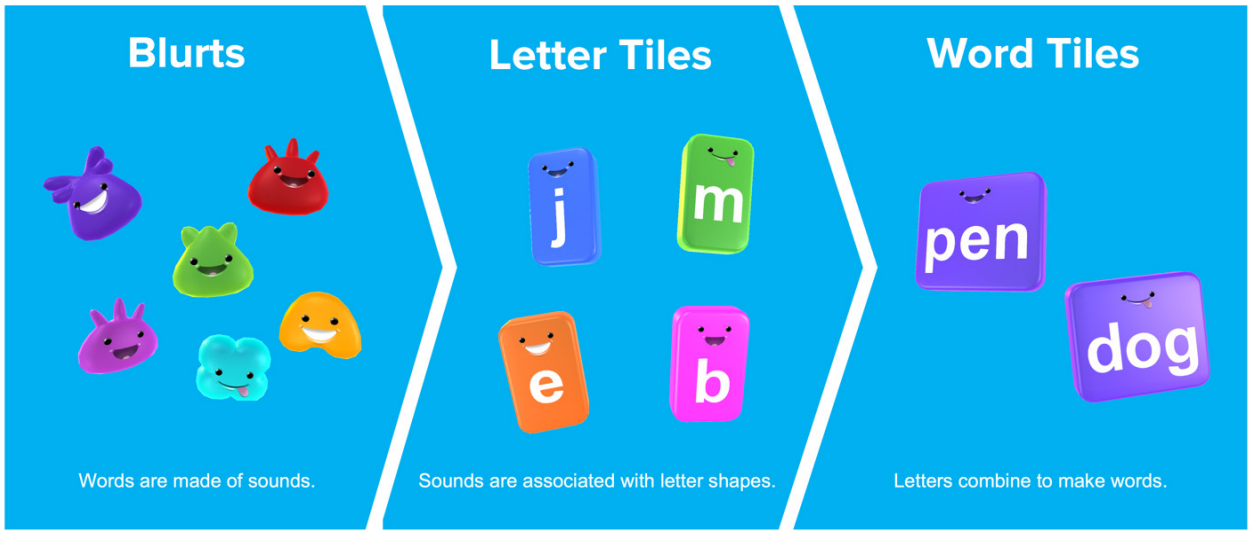


Figure 7. Phonological progression of activities from Blurts to Letter Tiles to Word Tiles

Learning Sounds with Blurts

First, children use manipulatives called *Blurts* to learn and hear the sounds that create words. Children build phonemic awareness skills by identifying the first, middle, and last sounds in spoken words. Then they practice building and segmenting spoken words with Blurt sounds and eventually learn how to add, delete, substitute, and manipulate sounds into words. For example, in Sound Hound, children receive a word card, such as the picture of a goat, and must use the Blurts on-screen to answer questions about the sounds that make up the word (see Figure 8).

Figure 8. The Sound Hound game teaches children to identify the sounds representing an image.

Children use Blurts and Letter Tiles to engage in phonological awareness activities that enable them to practice rhyming, alliteration, syllable counting, syllable deletion, syllable substitution, and, eventually, poems and nursery rhymes. Phonological awareness skills are also taught explicitly through video instruction with a live actor.

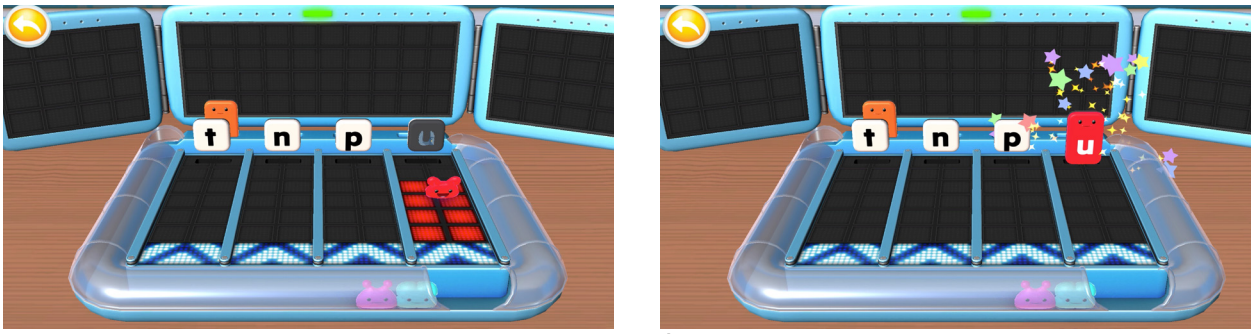
Learning Letter Shapes with Letter Tiles

As children gain fluency with sounds and syllables, they also work to associate those sounds with letters. In *My Reading Academy*, children manipulate Letter Tiles to learn the sounds each letter represents. Children engage in phonics learning through games that practice letter-sound correspondence, consonant-vowel-consonant decoding, spelling, and sound-by-sound blending.

For example, Sound Slider is a game that helps children see the connection between letters and the sounds they stand for (see Figure 9).

Figure 9. The Sound Slider game teaches children how sounds represent letters.

The child places the Blurt by the letter that stands for the Blurt's sound (see Figure 10a), and the Blurt slides down the stage to form a Letter Tile (see Figure 10b).



a. b.

Figure 10. The child places the Blurt sound for /u/ on the slide leading up to the letter *u*. The Blurt and letter combine to create an interactive Letter Tile that represents the sound and letter shape for *u*.

Learning Sight Words with Letter Tiles

With orthographic mapping, we store parts of words in our memory that can later be combined into full sight words. In *My Reading Academy*, children play Twirly Words to practice building and recognizing sight words (see Figure 11). The players start the game by placing Letter Tiles on the carousel that combine to spell each sight word (e.g., *i* and *t* form *it*). The resulting Word Tiles move onto a spinning carousel filled with other words. The child must tap the screen to take a photo of the target sight word each time they see it. Through teaching videos with Miracle and Nano that precede gameplay, children receive explicit instruction about each set of sight words. This instruction is aligned to the phonic sequence and is presented according to the frequency with which each word appears in the written language.

Figure 11. The Twirly Words game teaches children to practice building and spotting sight words.

Reading Experiences

In *My Reading Academy*, game experiences are designed to help children master foundational reading skills. The purpose of book reading experiences is to help children apply these skills strategically to comprehend text. Books teach children various reading strategies, such as comprehension monitoring, making predictions or inferences, asking questions, and visualizing.

Miracle and Nano provide engaging support for these strategies throughout most books. This support begins with a brief introductory video, in which they set a purpose for reading the book or teach a Learning Objective. They reinforce this purpose or Learning Objective midway through the book during a think-aloud video or audio, then reflect on their learning during a post-book video. Most books are also accompanied by comprehension questions that gradually increase in complexity as children advance through the system.

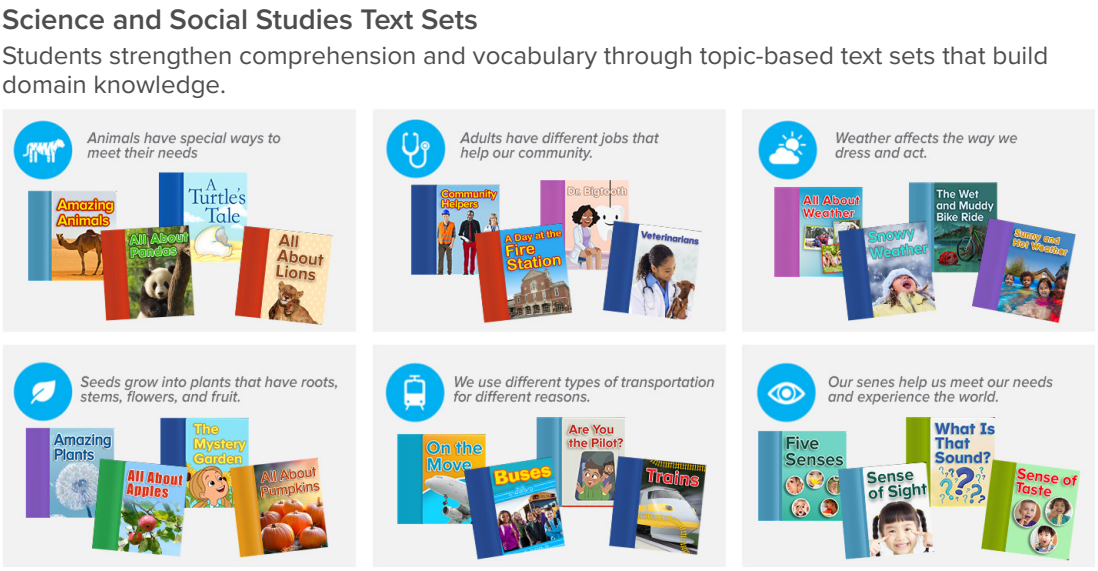


Figure 12. Types of science and social studies texts in *My Reading Academy*

My Reading Academy provides a rich collection of texts, including fiction, informational, classic, and modern book selections (see Figure 12). Books include diverse representations of people, places, and cultures and consist of topics relevant to children's everyday lives, such as animals and plants, transportation, weather, human body parts, and community (see Figure 13). Science and social studies content boost children's background knowledge, supporting greater comprehension of informational text.

Figure 13. Diverse book experiences build vocabulary and comprehension.

Taken together, reading experiences in *My Reading Academy* augment gameplay experiences by teaching children fundamental reading strategies with a diverse set of books and by having them engage with Miracle and Nano.

Personalized to Meet Each Child's Needs

My Reading Academy is personalized to meet each child's needs. As teachers help children learn the components of reading, it's essential for them to understand each child's strengths and weaknesses (Duke & Cartwright, 2021) and match the intensity and complexity of their teaching with the child's current skills and needs (Snow et al., 1998).

Supporting Multiple Learning Trajectories

Each learner has different skills, knowledge, and experiences. As children learn new concepts, these concepts build upon their prior knowledge. Since each child has a unique set of prior knowledge, each classroom will have multiple learning trajectories.

Learner variability describes how each child has a different set of concepts that they know, don't yet know, and are ready to learn. Learning is not simply the linear accumulation of knowledge. Instead, learning involves understanding and applying an interconnected collection of knowledge, skills, and ways of thinking that we represent using the Architecture of Understanding™. The Architecture of Understanding represents what children know (green bricks), what they don't know (grey bricks), and any misconceptions (red bricks; see Figure 14).

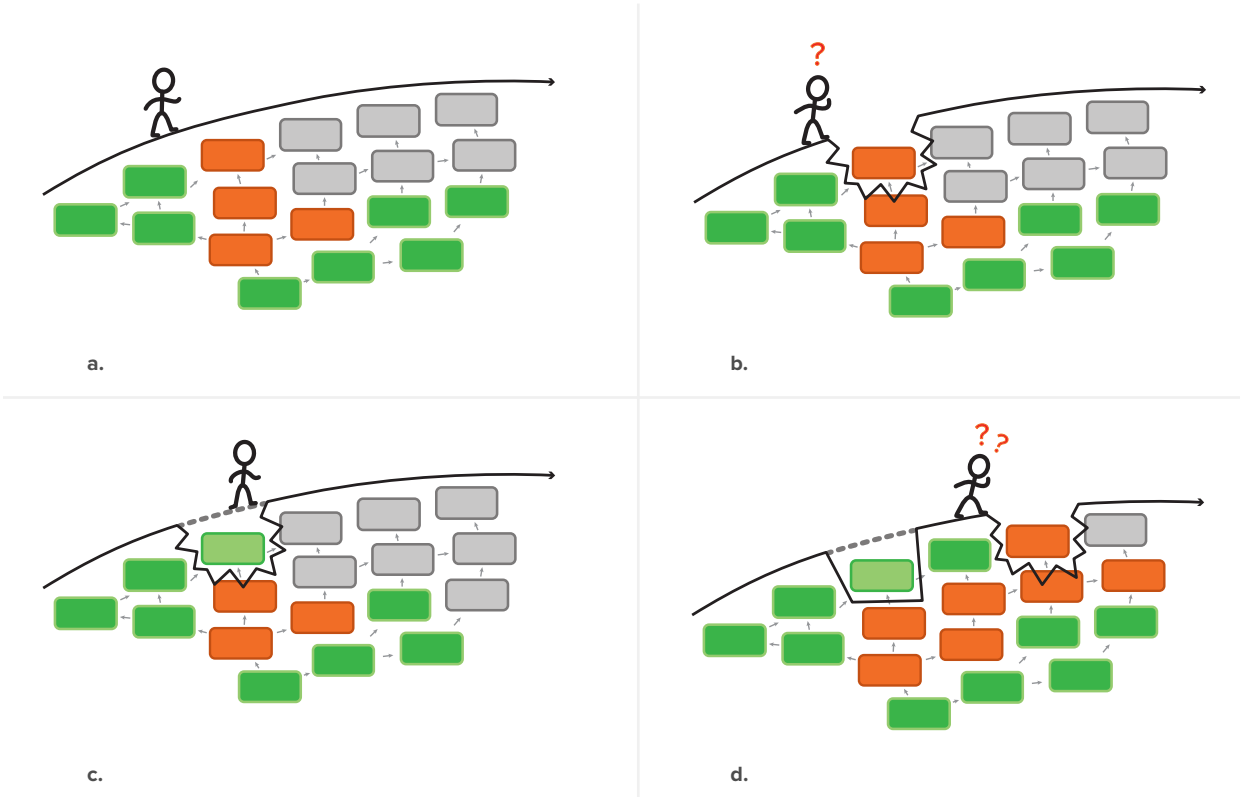


Figure 14 The Architecture of Understanding (a) shows what a child knows (green bricks), what a child doesn't know (grey bricks), and any misconceptions (red bricks). Underlying flaws in a child's knowledge eventually appear on the surface (b). Scaffolding (dashed lines) can help children overcome some problems and continue learning (c). However, when left unaddressed, underlying issues will eventually resurface (d).

When a child tries to learn new things that connect to a faulty understanding, these new ideas may also be misunderstood. Over time, entire sections of a child's architecture may become inaccurate or unstable. These

issues may not be apparent on the surface; however, they will eventually appear during subsequent learning. Through tips, tricks, algorithms, and other means, the child can address this surface issue and update their Architecture of Understanding to continue learning. However, these surface-level strategies may help the child get past the stumbling block, but they won't necessarily address deeper misunderstandings that led to the underlying problem. For instance, when a child struggles to read a word, it's important to know why they're struggling, because the teacher's scaffolding is dependent on whether the issue involves knowing the letters, the ability to sound out parts of the word, identifying syllables, other issues, or a combination of these issues. Consequently, this misunderstanding is connected to more knowledge, which will affect knowing and understanding until the problem is addressed.

So far, this is the architecture of one child's understanding—the map of what they know and do not know. Every child's Architecture (or map) of Understanding is different. Even if teachers see that other children have trouble mastering the same content, what lies beneath the surface—the reason they are struggling—is likely unique to each learner (see Figure 15).

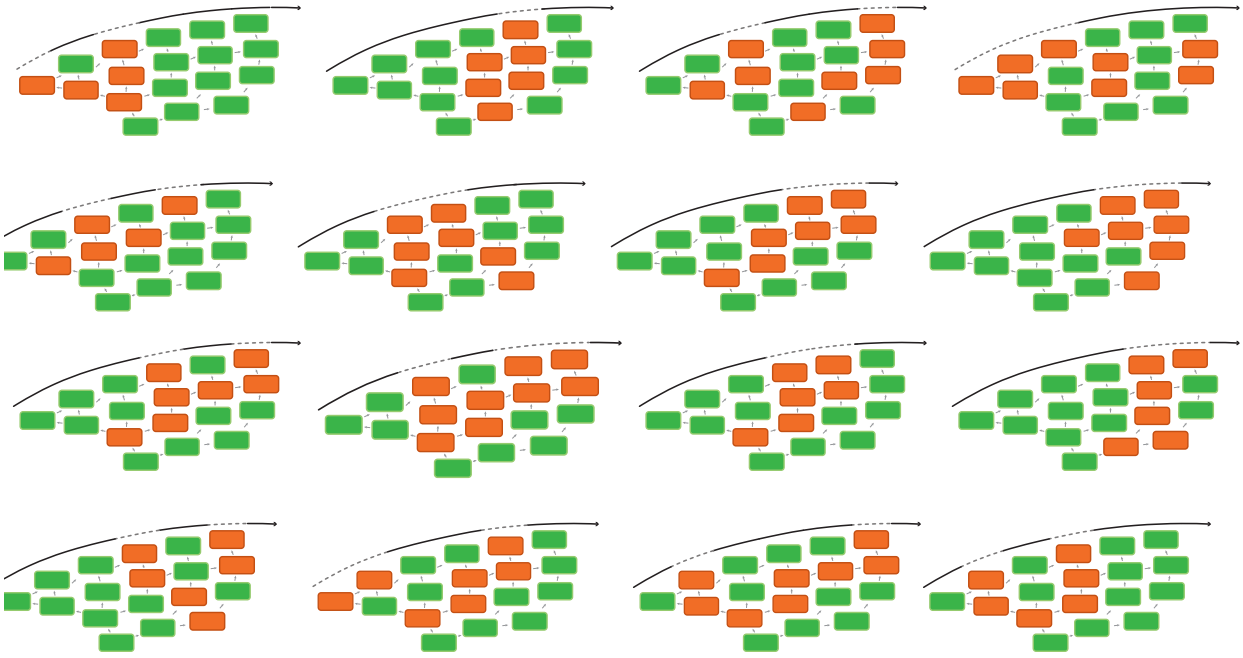


Figure 15. The Architectures of Understanding for 16 children, each with a different set of knowledge

Given that learner variability exists, a one-size-fits-all approach does not work for all children and can contribute to gaps in knowledge (Lannin et al., 2013). Each learner has their own learning trajectory, or pathway, through a hierarchy of goals and activities where each successive objective is designed to build on the understanding and mastery of previous objectives (Clements & Sarama, 2004; Sarama & Clements, 2004; Thai et al., 2021).

Adapting Learning Trajectories for Individual Learners

The main feature distinguishing *My Reading Academy* from its competitors as an education technology solution is its adaptivity. *My Reading Academy* is carefully and intentionally designed to meet the needs of diverse learners who undergo various learning trajectories on the path to reading mastery, and it does so

through its adaptive digital instruction system, the Personalized Mastery Learning System (PMLS; Dohring et al., 2019). The PMLS supports children's learning in many ways throughout gameplay. This system first assesses children's prior knowledge, then provides instruction, evaluates mastery, gives scaffolded feedback to children, and guides them to developmentally appropriate games based on their current level of knowledge. Specifically, the PMLS pinpoints where children already demonstrate mastery in reading through a pre-assessment, then identifies areas of children's learning needs. From here, *My Reading Academy* provides instruction for these areas; assesses mastery; provides corrective feedback, if necessary; and automatically guides children to the place they are most ready to learn next. While children learn more about reading through the game, the game also learns about each child and how they learn best.

There is no one path to reading mastery, and each path is complex, often nonlinear, and full of challenges. For instance, Figure 16 shows a comparison of three children.

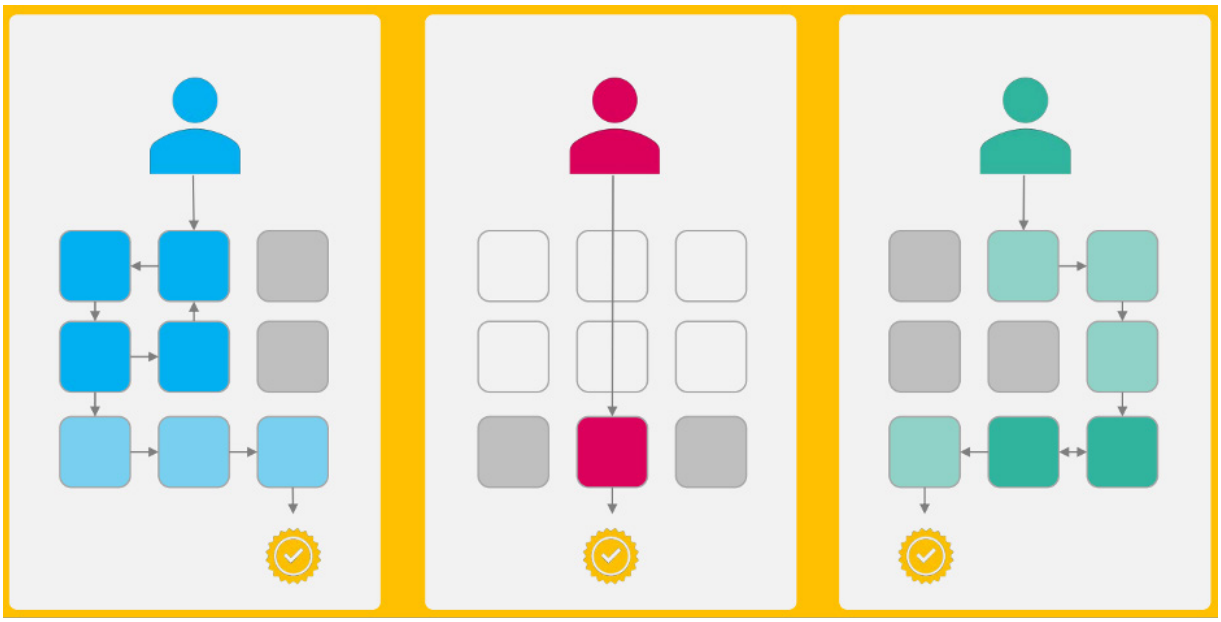


Figure 16. There are multiple paths to reading mastery, and each of these three learners follows a different trajectory.

As illustrated above, the first child stays in one particular topic within an area (e.g., Phonological Awareness) before moving on to other topics and eventually displaying mastery in that area. The second child has a direct, linear pathway to mastery within that area, skipping nodes that represent Learning Objectives the game predicts they have already mastered based on their previous performance. The third child is somewhere between the first two children in their path to mastery: Their path is more linear than the first child, occasionally repeating nodes if they struggle with a particular Learning Objective. In all of these instances, *My Reading Academy* uses the Personalized Mastery Learning System to develop an understanding of each child's knowledge through gameplay, to offer optimized, personalized instruction that supports each on their own unique path to reading. Taken together, *My Reading Academy* uses ongoing formative assessment (collected during regular gameplay) and summative assessment (collected through un-scaffolded, final "boss levels") to evaluate proficiency and inform adaptivity in an iterative process that grows along with each child.

Assessing and Modeling Learning in Real Time

One way to detect misunderstandings, misconceptions, or simply missed ideas is through granular identification and dynamic assessment of all specific concepts and skills required for proficiency in a topic.

While one-on-one tutoring has demonstrated success (e.g., Bloom's Mastery Learning Model), such dynamic formative assessment may be unrealistic for teachers who may not have the time or training to identify these issues, much less correct them for each child in the classroom.

By consistently assessing learners and gathering data about what they know and what they don't know, *My Reading Academy* can provide scaffolding structures and formative feedback personalized to each player. *My Reading Academy* can precisely monitor where each child is in their reading knowledge trajectory. More importantly, it can then provide a personalized set of activities adapted to what the learner needs, just in time to use them.

Taken together, game-based assessments measure each child's progress, the Architecture of Understanding models their mastery of Learning Objectives in the Knowledge Map, and each of these informs adaptive placement in the program. Therefore, *My Reading Academy* can dynamically assess child progress and offer personalized Learning Paths.

Empowering for Parents and Teachers

Personalized Mastery Learning Ecosystem

All of these features, including the PMLS, are part of the Personalized Mastery Learning Ecosystem (PMLE; see Figure 17), Age of Learning's unique approach that uses technology to connect children's home and school environments, leveraging the learning opportunities from these environments to address learner variability. The first part of the PMLE is the Personalized Mastery Learning System or the digital learning component, where support is offered directly to the learner through in-game interactions and experiences. The ecosystem also extends beyond the learner to the caregivers and teachers who provide their own layers of support and influence to children while they learn to read (Bronfenbrenner, 1986, 1992, 1999; Neal & Neal, 2013). In this way, the PMLE is also heavily informed by Bloom's (1984) Four Objects of Change. High-quality instructional materials, or the *My Reading Academy* games themselves, are not enough to make meaningful positive change in children's learning. Supports must also be created in the learner's home and school environments.

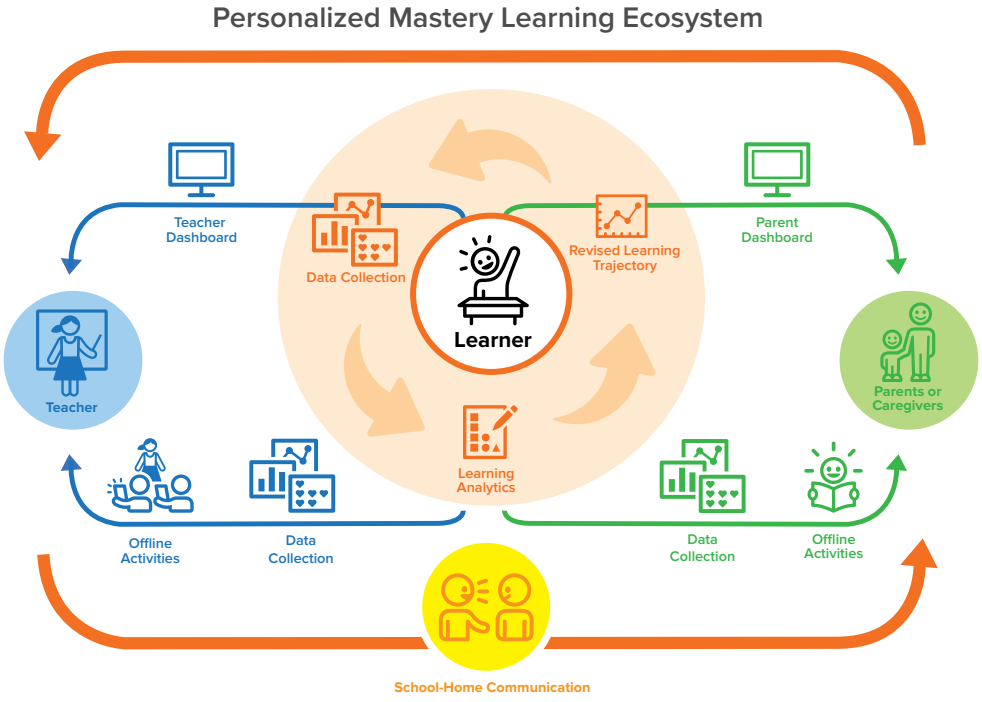


Figure 17. The Personalized Mastery Learning Ecosystem

My Reading Academy creates additional supports in the child's environment through another level of personalization: real-time data to parents and teachers on children's experiences within *My Reading Academy* in the form of a user-friendly interactive Dashboard. This Dashboard is designed to facilitate and inform interactions between all levels of children's learning environments, including their parents, teachers, and the children themselves. While the child engages with the game, data are collected on these interactions and presented to parents and teachers via the Dashboard. The parents and teachers can then use these data-informed resources to communicate with each other on how to best support the child outside of gameplay. In brief, the Dashboard is an essential part of the PMLE, saving precious instructional time for teachers and parents and empowering them to be agents of change for children of all levels of reading skills.

Logic Model

Many children in the U.S., especially those from underserved backgrounds, cannot formally demonstrate the ability to read with accuracy, understanding, and fluency. Due to the complexity of early reading skills, instruction needs to be adaptive, catering to each child's needs. *My Reading Academy* is a tool that aims to address this problem. Below is our program logic model illustrating a roadmap to address the problem (see Figure 18). This model details the process through which *My Reading Academy's* Personalized Mastery Learning Ecosystem results in both short- and long-term benefits for children and their teachers, administrators, and caregivers.

LearnPlatform collaborated with Age of Learning to design the logic model to satisfy Level IV requirements (Demonstrates a Rationale) according to the Every Student Succeeds Act (ESSA).

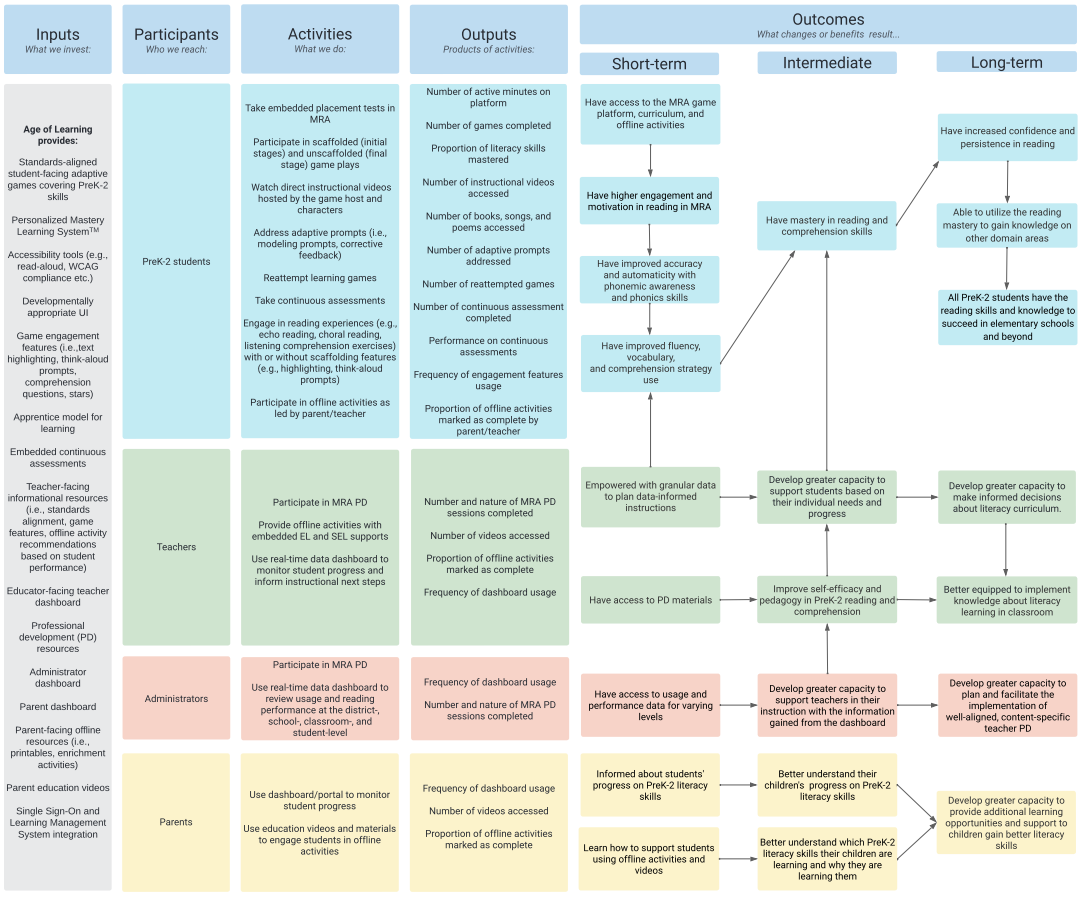


Figure 18. Logic model for *My Reading Academy*

Conclusion

This white paper describes how *My Reading Academy* is a research-driven, adaptive, engaging, and empowering game-based solution to forming the building blocks for reading success. Grounded in the science of reading, *My Reading Academy* provides a comprehensive reading system that teaches children to read with short bursts of instruction and formative feedback from charming digital "friends," purposeful practice in fun game formats, and immersive reading experiences that cultivate a love of reading. Through adaptive and formative assessments, *My Reading Academy* fosters multiple learning trajectories for children. It also provides real-time actionable data for teachers and administrators, as well as instructional resources and at-home activities for families and caregivers.

Appendix 1. Common Terms from the Science of Reading

The science of reading describes 50 years of best practices for understanding literacy and teaching reading. Not surprisingly, there are many different—and sometimes confusing—terms for the language learning mechanisms and units.

Long before children learn how to read, they learn to hear, recognize, and eventually produce language through talking. *Phonological awareness* describes how we learn to hear and manipulate the sounds of speech, including phonemes, syllables, and words. Learning to read is then a process of mapping spoken language, written language, and meaning across words. As described above in the section on the science of reading, there are many foundational skills involved in word recognition and reading comprehension. To read words, a child must learn how sounds correspond to letters (i.e., the *alphabetic principle*).

In literacy research, spoken language is comprised of individual and perceptually distinct sounds that are referred to as *phonemes*. In English, there are 44 phonemes. When converting speech sounds into readable text, phonemes are written using the 26 letters of the alphabet and represented as a sound by surrounding the phoneme with forward slashes. For example, the sound of a "d" as in *dog* can be represented as /d/. However, not all letters have unique phonemes. For example, the sound /sh/ can be spelled using *sh*, *ce*, *s*, *ci*, *si*, *ch*, *sci*, and *ti* in words, such as the *ocean*, *sure*, *machine*, and *conscience*. The letters or groups representing each phoneme are called *graphemes,* which signify alternative spellings and uses of the same phoneme. In another example, the letter *k* and the sound /k/ as in *kit*, can be written using the following graphemes: *c, k, x, ck, qu, q(u), ch, cc,* or *lk*. In English, there are about 250 graphemes.

Finally, phonemes and their grapheme representations can be combined to form *morphemes,* the smallest unit of meaning. Morphemes consist of a word or word element (e.g., prefix, suffix, or roots). For instance, the word *unpredictable* is comprised of the following morphemes:

un + pre + dict + able

My Reading Academy teaches children to read using interactive phonemes and graphemes to make learning about letter-sound correspondences more understandable and engaging. Each phoneme is an interactive character, called a *Blurt*, that makes the sound of a specific phoneme when tapped. For example, when the green Blurt in Figure 19 is tapped in the game, it would make the sound /sh/. When the blue Blurt is tapped, it makes the sound /ē/. Children play different games with the phoneme Blurts to build *phonemic awareness* by learning the individual sounds of a language. To learn about graphemes, children use interactive Letter Tiles that show the grapheme in the middle and make the associated phoneme when tapped. In other games, children combine Letter Tiles to form words. When a child creates a word out of Letter Tiles, the resulting Word Tile will now make the sound of the word when tapped. For example, the Letter Tiles *sh* and *e* are combined to make the Word Tile *she*.

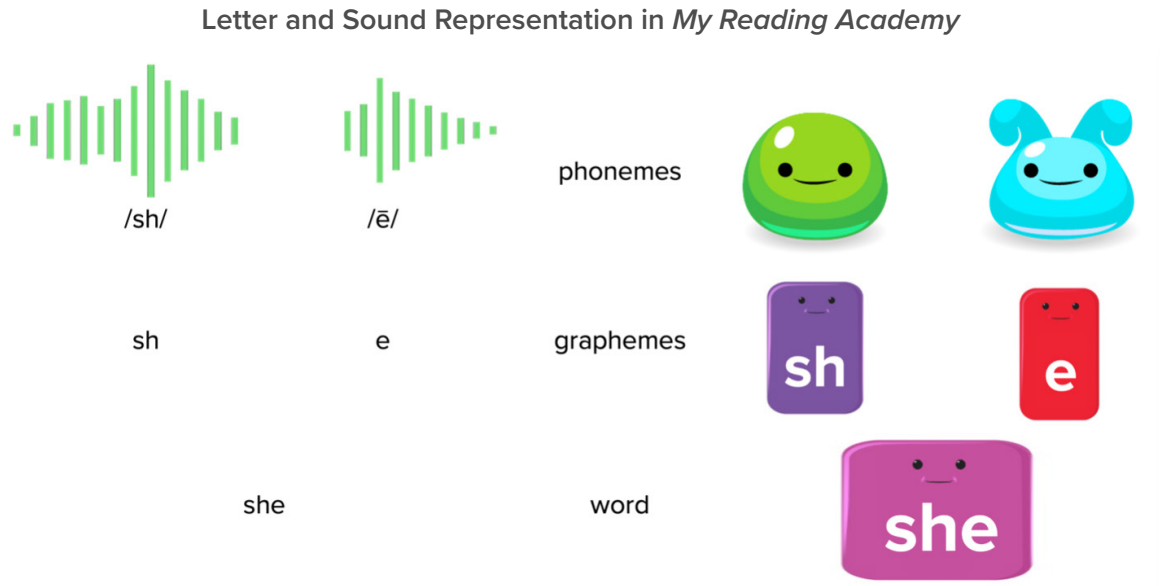


Figure 19. Letter and sound representation in *My Reading Academy*

Phonemic awareness can be built by identifying and segmenting phonemes and then adding, deleting, substituting, or reversing sounds in words. Blurts and tiles foster phonemic awareness by making phonemes and graphemes interactive and manipulatable.

As children encounter new words, they use *orthographic mapping* (described above) to form letter-sound relationships and they use this knowledge for spelling, pronunciation, and storing words in long-term memory. The first step in this process is when children use *phonic decoding* to sound out a word using letter-sound knowledge and blending sounds together to produce words.

Once a word can be instantly recognized, it is referred to as a *sight word* in a child's *sight vocabulary*, which includes the bank of words instantly recognized by the child. Instant recall of a sight word is called *word recognition*.

Phonics is the teaching system that maps phonemic awareness onto letters and spellings.

References

Adams, M. J. (1990). *Beginning to read: Thinking and learning about print.* Cambridge, MA: MIT Press.

Amplify Reading. (2021). *COVID-19 means more students not learning to read*. Retrieved from https://amplify.com/wp-content/uploads/2021/02/Amplify-mCLASS_MOY-COVID-Learning-Loss-Research-Brief_022421.pdf

Archer, A., & Hughes, C. (2011). *Explicit instruction: Effective and efficient teaching. New* York, NY: Guilford.

Baker, L. (2003). The role of parents in motivating struggling readers. *Reading and Writing Quarterly, 19*(1), 87–106. https://doi.org/10.1080/10573560308207

Barab, S., Thomas, M., Dodge, T., Carteaux, R., & Tuzun, H. (2005). Making learning fun: Quest Atlantis, a game without guns. *Educational Technology Research and Development, 53*(1), 86–107. https://doi.org/10.1007/BF02504859

Bloom, B. S. (1984). The 2 sigma problem: The search for methods of group instruction as effective as one-to-one tutoring. *Educational Researcher, 13*(6), 4–16. https://doi.org/10.3102/0013189X013006004

Bronfenbrenner, U. (1986). Ecology of the family as a context for human development: Research perspectives. *Developmental Psychology, 22*(6), 723–742. https://doi.org/10.1037/0012-1649.22.6.723

Bronfenbrenner, U. (1999). Environments in developmental perspective: Theoretical and operational models. In S. L. Friedman & T. D. Wachs (Eds.), *Measuring environment across the life span: Emerging methods and concepts* (pp. 3–28). American Psychological Association. https://doi.org/10.1037/10317-001,Inc.

Castles, A., Rastle, K., & Nation, K. (2018). Ending the reading wars: Reading acquisition from novice to expert. *Psychological Science in the Public Interest, 19,* 5–51. https://doi.org/10.1177/1529100618772271

Chase, C. C., Chin, D. B., Oppezzo, M. A., & Schwartz, D. L. (2009). Teachable agents and the protégé effect: Increasing the effort towards learning. *Journal of Science Education and Technology, 18*(4), 334–352.

Chatterji, M. (2006). Reading achievement gaps, correlates, and moderators of early reading achievement: Evidence from the Early Childhood Longitudinal Study (ECLS) kindergarten to first grade sample. *Journal of Educational Psychology, 98*(3), 489–507. https://doi.org/10.1037/0022-0663.98.3.489

Clements, D. H., & Sarama, J. (2004). Learning trajectories in mathematics education. *Mathematical Thinking and Learning, 6(2),* 81–89. https://doi.org/10.1207/s15327833mtl0602_1

Dietze, B., & Kashin, D. (2011). *Playing and learning in early childhood education.* Toronto, ON: Pearson Education Canada.

Dohring, D. C., Hendry, D. A., Gunderia, S., Hughes, D., Owen, V. E., Jacobs, D. E., Betts, A., & Salak, W. (2019). *Personalized mastery learning platforms, systems, media, and methods* (U.S. Patent No. 10490092B2). U.S. Patent and Trademark Office. https://patents.google.com/patent/US10490092B2/en

Duke, N. K., & Cartwright, K. B. (2021). The science of reading progresses: Communicating advances beyond the simple view of reading. *Reading Research Quarterly, 56*(S1), S25–S44. https://doi.org/10.1002/rrq.411

Ehri, L. C. (1995). Phases of development in learning to read words by sight. *Journal of Research in Reading, 18*(2), 116–125. https://doi.org/10.1111/j.1467-9817.1995.tb00077.x

Ehri, L. C. (2014). Orthographic mapping in the acquisition of sight word reading, spelling memory, and vocabulary learning. *Scientific Studies of Reading, 18*(1), 5–21. https://doi.org/10.1080/10888438.2013.819356

Ehri, L. C., & Snowling, M. J. (2004). Developmental variation in word recognition. In B. Shulman, K. Apel, B. Ehren, E. Silliman, & C. Stone (Eds.), *Handbook of language and literacy development and disorders* (pp. 433–460). New York, NY: Guilford.

Fisher, K., Hirsh-Pasek, K., Golinkoff, R. M., Singer, D. G., & Berk, L. (2011). Playing around in school: Implications for learning and educational policy. In A. D. Pellegrini (Ed.), *The Oxford handbook of the development of play* (pp. 341–360). *Oxford, UK: Oxford University Press.*

Fisher, K. R., Hirsh-Pasek, K., Newcombe, N., & Golinkoff, R. M. (2013). *Taking shape: Supporting preschoolers' acquisition of geometric knowledge through guided play. Child Development, 84*(6), 1872–1878. https://doi.org/10.1111/cdev.12091

Foster, W. A., & Miller, M. (2007). Development of the literacy achievement gap: A longitudinal study of kindergarten through third grade. *Language, Speech, and Hearing Services in Schools, 38*(3), 173–181. https://doi.org/10.1044/0161-1461(2007/018)

Golinkoff, R., Hirsh-Pasek, K., & Eyer, D. (2004). *Einstein never used flashcards: How our children really learn and why they need to play more and memorize less. New York, NY:* Rodale Books.

Goodman, I., Libenson, A., & Wade-Woolley, L. (2010). Sensitivity to linguistic stress, phonological awareness, and early reading ability in preschoolers. *Journal of Research in Reading, 33*(2), 113–127. https://doi.org/10.1111/j.1467-9817.2009.01423.x

Gough, P. B., & Tunmer, W. E. (1986). Decoding, reading, and reading disability. *Remedial and Special Education, 7*(1), 6–10. https://doi.org/10.1177/074193258600700104

Hanford, E. (Correspondent). (2018, September 10). Hard words: Why aren't our kids being taught to read? [Audio podcast episode]. In *The Educate Podcast*. American Public Media. https://www.apmreports.org/episode/2018/09/10/hard-words-why-american-kids-arent-being-taught-to-read

Hanson, R. A., & Farrell, D. (1995). The long-term effects on high school seniors of learning to read in kindergarten. *Reading Research Quarterly, 30*(4), 908–933. https://doi.org/10.2307/748204

International Literacy Association. (2019). *Phonological awareness in early childhood literacy development* [Position statement and research brief]. Newark, DE: Author.

Kuhfeld, M., Soland, J., Tarasawa, B., Johnson, A., Ruzek, E., & Liu, J. (2020). Predicting the potential impact of COVID-19 school closures on academic achievement. *Educational Researcher, 49*(8), 549–565. https://doi.org/10.3102/0013189X20965918

La Paro, K. M., & Pianta, R. C. (2000). Predicting children's competence in the early school years: A meta-analytic review. *Review of Educational Research, 70*(4), 443–484. https://doi.org/10.3102/00346543070004443

McClelland, M. M., Cameron, C. E., McDonald Connor, C., Farris, C. L., Jewkes, A. M., & Morrison, F. J. (2007). Links between behavioral regulation and preschoolers' literacy, vocabulary, and math skills. *Developmental Psychology, 43*(4), 947–959. https://doi.org/10.1037/0012-1649.43.4.947

Miles, S. B., & Stipek, D. (2006). Contemporaneous and longitudinal associations between social behavior and literacy achievement in a sample of low-income elementary school children. *Child Development, 77(1), 103*–117. https://doi.org/10.1111/j.1467-8624.2006.00859.x

Mislevy, R. J., Almond, R. G., & Lukas, J. F. (2003). A brief introduction to evidence-centered design. *ETS Research Report Series, 2003*(1), i–29.

Mislevy, R. J., Oranje, A., Bauer, M. I., von Davier, A. A., & Hao, J. (2014). *Psychometric considerations in game-based assessment. GlassLab Games.*

Murnane, R., Sawhill, I., & Snow, C. (2012). Literacy challenges for the twenty-first century: Introducing the issue. *The Future of Children, 22*(2), 3–15. https://doi.org/10.1353/foc.2012.0013

National Institute of Child Health and Development (NICHD). (2000). *Report of the National Reading Panel: Teaching children to read: An evidence-based assessment of the scientific research literature on reading and its implications for reading instruction* (NIH Publication No. 00-4769). Washington, DC: U.S. Government Printing Office.

Neal., J. W., & Neal, Z. P. (2013). Nested or networked? Future directions for ecological systems theory. *Social Development, 22*(4), 722–737. https://doi.org/10.1111/sode.12018

Otaiba, S. A., & Fuchs, D. (2006). Who are the young children for whom best practices in reading are ineffective? An experimental and longitudinal study. *Journal of Learning Disabilities, 39*(5), 414–431. https://doi.org/10.1177/00222194060390050401

Owen, V. E., & Hughes, D. (2019). Bridging two worlds: Principled game-based assessment in industry for playful learning at scale. In *Game-Based Assessment Revisited* (pp. 229–256). Springer, Cham.

Pearson, P. D., & Gallagher, M. C. (1983). The instruction of reading comprehension. *Contemporary Educational Psychology, 8*(3), 317–344. https://doi.org/10.1016/0361-476X(83)90019-X

Petscher, Y., Cabell, S. Q., Catts, H. W., Compton, D. L., Foorman, B. R., Hart, S. A., Lonigan, C. J., Phillips, B. M., Schatschneider, C., Steacy, L. M., Terry, N. P., & Wagner, R. K. (2020). How the science of reading informs 21st-century education. *Reading Research Quarterly, 55*(S1), S267–S282. https://doi.org/10.1002/rrq.352

Pier, L., Christian, M., Tymeson, H., & Meyer, R. H. (2021). *COVID-19 impacts on student learning: Evidence from interim assessments in California [Report]. Policy Analysis for California Education.* https://edpolicyinca.org/publications/covid-19-impacts-student-learning

Purpura, D. J., Hume, L. E., Sims, D. M., & Lonigan, C. J. (2011). Early literacy and early numeracy: The value of including early literacy skills in the prediction of numeracy development. *Journal of Experimental Child Psychology, 110*(4), 647–658. https://doi.org/10.1016/j.jecp.2011.07.004

Sarama, J., & Clements, D. H. (2004). Building Blocks for early childhood mathematics. *Early Childhood Research Quarterly, 19*(1), 181–189. https://doi.org/10.1016/j.ecresq.2004.01.014

Scammacca, N., Fall, A., Capin, P., Roberts, G., & Swanson, E. (2020). Examining factors affecting reading and math growth and achievement gaps in grades 1–5: A cohort-sequential longitudinal approach. *Journal of Educational Psychology, 112*(4), 718–734. https://doi.org/10.1037/edu0000400

Scarborough, H. S. (2001). *Connecting early language and literacy to later reading (dis)abilities: Evidence, theory, and practice.* In S. B. Neuman & D. K. Dickinson (Eds.), Handbook of early literacy research (pp. 97–110). New York, NY: Guilford.

Shute, V. J., & Kim, Y. J. (2014). Formative and stealth assessment. In J. M. Spector, M. D. Merrill, J. Elen, & M. J. Bishop (Eds.), *Handbook of Research on Educational Communications and Technology.* https://doi.org/10.1007/978-1-4614-3185-5_25

Snow, C. E., Burns, M. S., & Griffin, P. (1998). *Preventing reading difficulties in young children.* Washington, DC: National Academy Press.

Snowling, M., & Hulme, C. (2011). Evidence-based interventions for reading and language difficulties: Creating a virtuous circle. *British Journal of Educational Psychology, 81*(1), 1–23. https://doi.org/10.1111/j.2044-8279.2010.02014.x

Squire, K. (2011). *Video games and learning: Teaching and participatory culture in the digital age.* New York, NY: Teachers College Press.

Stanovich, K. E. (1986). Matthew effects in reading: Some consequences of individual differences in the acquisition of literacy. *Reading Research Quarterly, 21*(4), 360–407. https://doi.org/10.1598/RRQ.21.4.1

Taylor, B. M., & Ysseldyke, J. E. (2007). *Educational interventions for struggling readers.* New York, NY: Teachers College Press.

Thai, K. P., Bang, H. J., & Li, L. (2021). Accelerating early math learning with research-based personalized learning games: A cluster randomized controlled trial. *Journal of Research on Educational Effectiveness, 15*(1), 28–51. https://doi.org/10.1080/19345747.2021.1969710

Torgesen, J. K. (2005). Recent Discoveries on Remedial Interventions for Children with Dyslexia. In M. J. Snowling & C. Hulme (Eds.), *The science of reading: A handbook* (pp. 521–537). *Blackwell Publishing.* https://doi.org/10.1002/9780470757642.ch27 U.S. Department of Education, National Center for Education Statistics. (2007). *The Nation's Report Card: Reading 2007* (NCES 2007-496). Washington, DC: U.S. Government Printing Office. https://nces.ed.gov/nationsreportcard/pdf/main2007/2007496.pdf

U.S. Department of Education, National Center for Education Statistics. (2019). *The Nation's Report Card: Reading 2019*. Washington, DC: U.S. Government Printing Office. https://www.nationsreportcard.gov/highlights/reading/2019/

Wagner, R. K., & Torgesen, J. K. (1987). The nature of phonological awareness and its causal role in the acquisition of reading skills. *Psychological Bulletin, 101,* 192–212. https://doi.org/10.1037/0033-2909.101.2.192

Whitehurst, G. J., & Lonigan, C. J. (1998). Child development and emergent literacy. *Child Development, 69*(3), 848–872. https://doi.org/10.2307/1132208