MyPath K–5

How MyPath K–5 Aligns With Research on Effective Reading and Mathematics Instruction

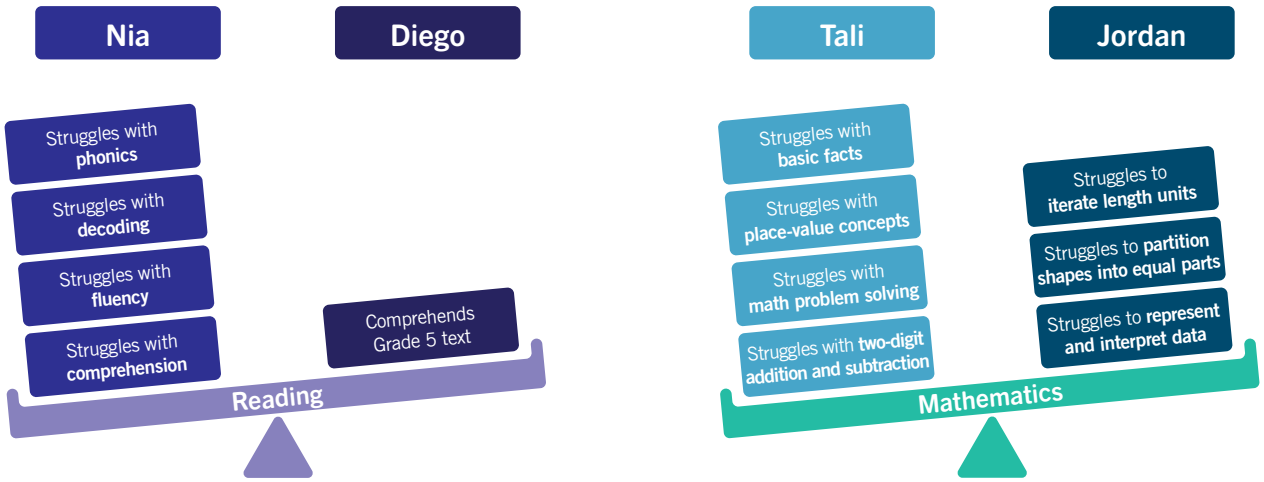
Edgenuity®

Contents

Overview

The Challenge

Educators across the country are doubling down on their efforts to improve student achievement after the 2019 National Assessment of Educational Progress (NAEP, 2019b) showed that only 35 percent of fourth graders scored Proficient (the ability to show competency in challenging subject matter) in reading and only 41 percent scored Proficient in mathematics (NAEP, 2019a). Teachers recognize the importance of calibrating instruction to meet learners' unique academic needs. The difficulty lies in the fact that classrooms are "becoming increasingly academically diverse," with children exhibiting increasingly different abilities, interests, and optimal ways of learning (Subban, 2006, p. 938). Consider the following Grade 3 classroom. In reading, Nia struggles with early literacy skills, which detrimentally affect grade-level comprehension. Diego comprehends text above grade level. In mathematics, Tali struggles with whole-number concepts. Jordan struggles with measurement and data concepts. Teaching is a constant balancing act, and personalizing lesson plans for a classroom of academically diverse students is challenging.



A growing number of educators turn to technology to offer personalized interventions that address students in the same class who have different abilities (Pane et al., 2017). Personalized learning is an approach to teaching that collects targeted data that pinpoints students' strengths and weaknesses. It organizes and continually adjusts instruction to meet individual student needs, rather than focusing only on grade-level content. The objective is to more efficiently facilitate and optimize student learning by meeting students where they are. Research shows that blending technology with teacher-led instruction may be particularly effective in helping struggling students succeed academically (Cavanaugh et al., 2013; Means et al., 2013; Pane et al., 2015; Stanford et al., 2010).

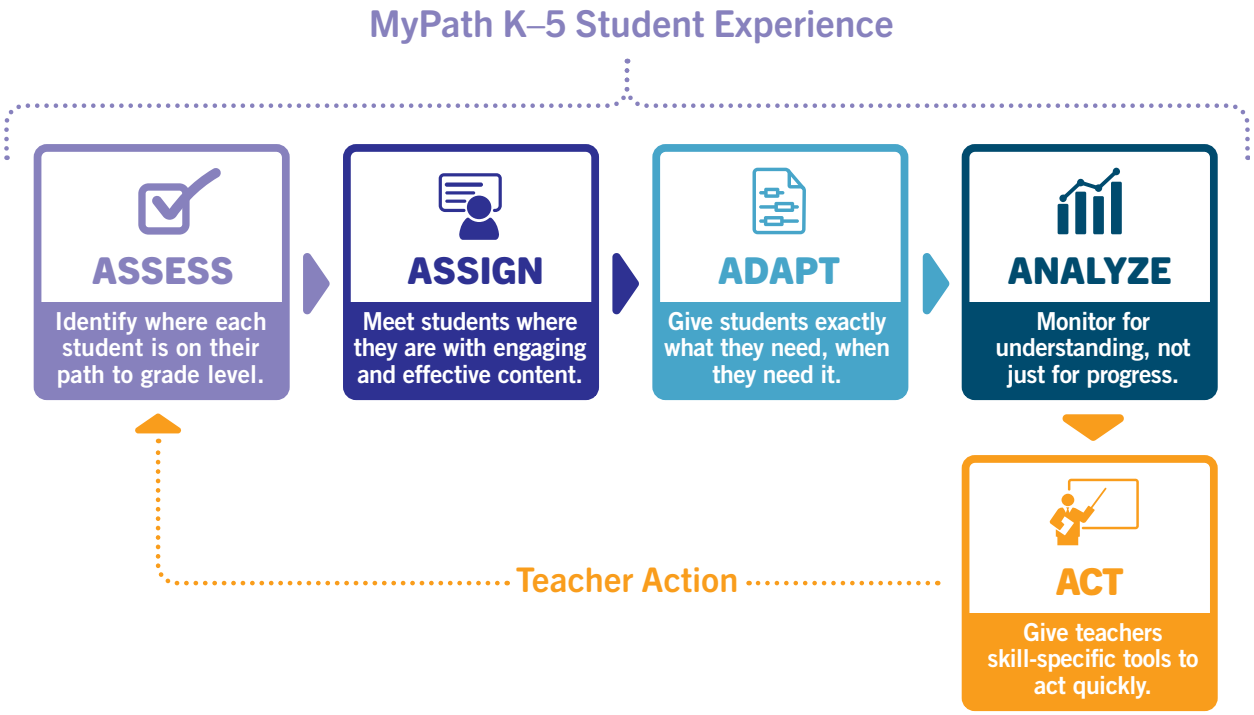
The Solution

Edgenuity's MyPath K–5 is the next generation of Pathblazer, a reading and mathematics program that the Center for Research and Reform in Education (CRRE) at Johns Hopkins University found to have a positive and statistically significant effect on reading comprehension for students in Grade 3 through Grade 5 (Wolf et al., 2020). This effect was especially powerful for students with, or at risk for, learning disabilities. MyPath K–5 extends Pathblazer with an all-new supplemental curriculum that utilizes **Smart Sequencer™** technology to prioritize and link critical skills within high-leverage standards with **age-appropriate** and **continuously adaptive** individual learning paths (ILPs) across reading and mathematics.

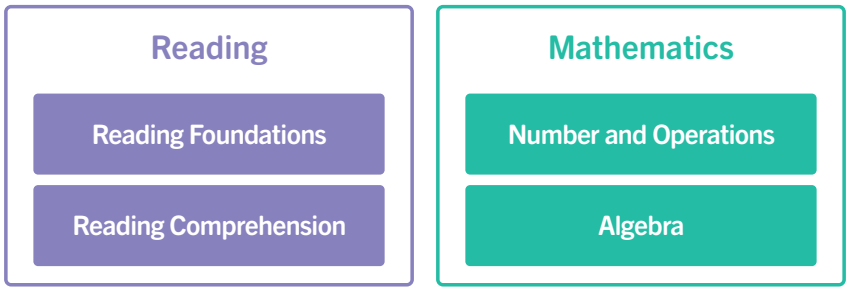
The curriculum:

- Assesses students' abilities and accurately identifies their instructional grade level.
- Prioritizes the critical skills within high-leverage standards with personalized and adaptive instruction, guided practice, and independent practice to meets students where they are and accelerate them to grade level.

- Provides ongoing data and analytics for educators, and incorporates offline downloadable teaching resources for students who need additional support.
- Offers engaging interactive rewards to motivate students to persevere and work hard.



MyPath K–5 uniquely leverages a cycle of assessment, assignment, adaptivity, analysis, and action to create a map of critical skill progressions that prioritizes grade-level content, ensuring students efficiently catch up, keep up, and get ahead. Student-assessment data (e.g., MyPath's integrated computer-adaptive test or third-party data from NWEA MAP® Growth™ or Renaissance Star®) automatically assign ILPs based on domain-level strengths and weaknesses. Teachers have the opportunity to modify the individual learning plan (ILP) if necessary. The curriculum prioritizes the following reading and mathematics domains:



ILPs focus on students' greatest needs, within and across domains. The curriculum's Smart Sequencer™ allows the program to seamlessly adapt to student performance. Integrated mastery checks drive the curriculum's adaptivity within lessons and across students' ILPs, targeting skill gaps as they emerge and allowing students to skip lessons on skills they have already mastered. For each concept, students take a five-item assessment. If they demonstrate mastery, they skip the lesson and move to the next skill in their ILP. If they struggle, the curriculum engages them in age-appropriate lessons designed to get them back on track quickly. These performance data allow the curriculum to continuously adapt content based on student needs.

Student dashboards motivate them to take ownership of their learning with embedded rewards and visual customization features. The program also seamlessly collects performance data within an intuitive dashboard, allowing teachers to make critical decisions for their students offline. Teacher dashboards allow teachers to analyze student data by domain in real time, equipping them with

actionable insights into their strengths and weaknesses. Teachers have access to downloadable offline resources to act quickly if students demonstrate consistent difficulty with a particular concept. Student performance with these tasks helps teachers prioritize and plan more intensive interventions, if necessary. This circular pattern continues, propelling students toward mastery of grade-level content. This innovative solution provides personalized learning tailored to each student's most pressing needs.

Research-Based Solution

MyPath K–5 incorporates six research-based principles of effective teaching to accelerate achievement:

1. Prioritize content and adapt learning based on student performance.
2. Provide accessible, explicit, and scaffolded instruction to ensure success among diverse learners.
3. Incorporate evidence-based practices for teaching reading.
4. Incorporate evidence-based practices for teaching mathematics.
5. Deliver actionable data to inform instructional decision-making.
6. Optimize student motivation and engagement.

Principle 1: Prioritize Content and Adapt Learning Based on Student Performance

Expert opinion and research support prioritizing grade-level content and critical foundational skills to accelerate students to grade level and beyond. This prioritization focuses on in-depth learning to ensure students meet rigorous standards. According to the Council of Great City Schools (2020), "Prioritizing content and learning does not mean that students will be deprived of critical knowledge, or that their educations will be any less diverse or rich" (p. 5). Rather, instruction should systematically address learning gaps in the context of grade-level standards, consistently remind students of prior knowledge, and explicitly connect foundational skills to the topic (Gersten, Beckmann, et al., 2009; Gersten, Compton, et al., 2009).

Intervention research in reading and mathematics confirms that struggling learners can attain rigorous standards if the instruction is explicit and systematic, and incorporates student support and opportunities for productive struggle and immediate feedback. For example, Kim et al. (2021) and Fuchs et al. (2021) tested the efficacy of these principles in two reading and mathematics interventions that both prioritized the most critical domain-specific grade-level standards, and developed a logical sequence of high-impact skills designed to scale students to success (e.g., concept mapping of domain-specific words, boosting magnitude understanding with number lines). The interventions in these studies did not teach every underlying skill or standard required to understand grade-level content. Rather, the interventions prioritized the highest-leverage skills essential for success, used principles of effective instruction to promote deep content knowledge, and filled in learning gaps to ensure student success. In both studies, intervention students outperformed equivalent controls on a range of reading and mathematics measures.

Prioritization is critical but insufficient for efficiently driving student success. Because students have diverse experiences and content knowledge, research supports continuously adapting instruction to address students' unique learning needs (Ankrum et al., 2020; Clark & Mayer, 2016; Subban, 2006; Tomlinson, 2014). Experts in teaching and learning also conclude that modifying the content and presentation of material to meet students' needs—known as adaptive teaching—is critical to promoting deeper transfer of learning (Fuchs et al., 2017; Parsons & Vaughn, 2016; Vagle, 2016). Adaptive teaching streamlines student success by prioritizing instruction and providing actionable insights for teachers to make critical instructional decisions. Nearly 15 years of research suggest that students who receive adaptive instruction demonstrate significantly greater gains in reading and mathematics than those who receive nonadaptive methods of instruction (Aleven et al., 2017; Alshammari et al., 2016; Ma et al., 2014; VanLehn, 2011; Ysseldyke & Tardrew, 2007).

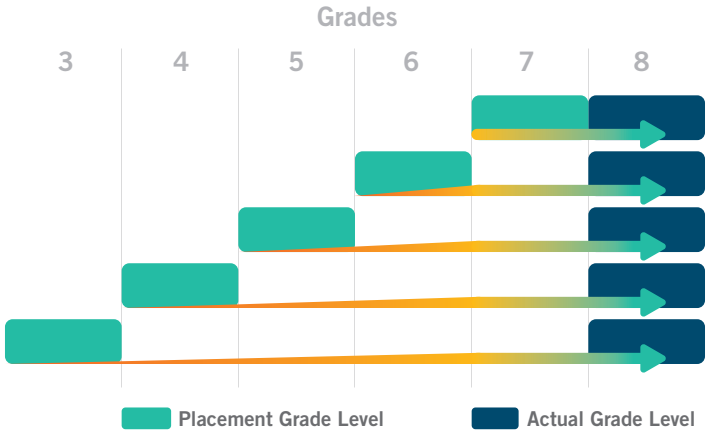
More specifically, effective adaptive learning models provide age-appropriate, dynamic, efficient, and engaging instruction. Older struggling students should receive age-appropriate content relevant to their daily academic and personal lives, rather than rote repetition of skills they should have mastered in prior grades (Linn et al., 2000; Salinger, 2003). The adaptive learning model should not be "one size fits all" (Wang et al., 2008, p. 2449). Adaptivity based on more than one learner variable (such as prior knowledge, presentation preferences, goals) significantly boosts student progress across content areas (A. Dhakshinamoorthy & K. Dhakshinamoorthy, 2019; Drachsler & Kirschner, 2011; Essalmi et al., 2010). Adaptivity is especially important for older struggling readers, because students cannot comprehend text without foundational reading skills (Coyne et al., 2013).

How MyPath K–5 Prioritizes Content and Adapts Learning

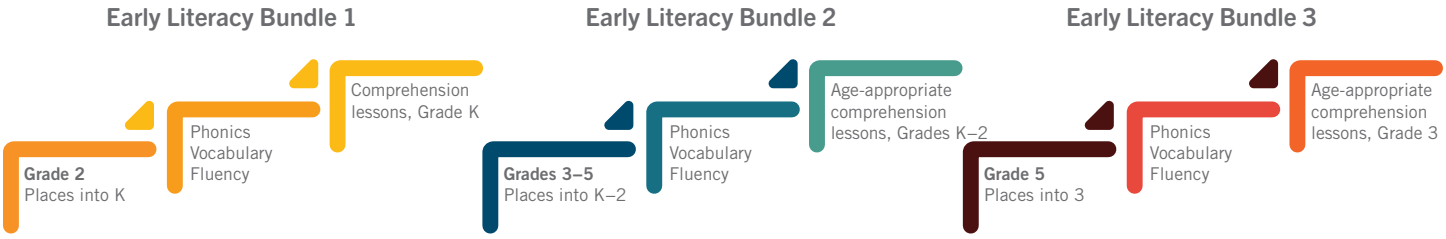
MyPath K–5 prioritizes grade-level content and critical foundational skills required to accelerate students' ability to comprehend text across domains and develop a conceptual understanding of mathematics at grade level and beyond. Program designers used coherence mapping (Student Achievement Partners, 2020) and research-based professional judgment to determine prioritized skills. Coherence mapping refers to the underlying idea that concepts across reading and mathematics domains connect within and across grades. This map of critical skills integrates with Smart Sequencer™ technology to seamlessly adapt the curriculum to address learning gaps in the context of grade-level standards. ILPs map the most critical prerequisites related to the grade's major work to efficiently build a ramp toward grade-level content.

If the student performs significantly below grade level, they likely demonstrate difficulty with a broader range of concepts. In that case, the ILP becomes more refined and laser focused by organizing essential skills into progressions (predetermined, researched, and purposeful sets of skills, agnostic of grade level) to accelerate growth more efficiently. These progressions allow students to focus on fewer skills to scale their ILP toward grade-level content.

MyPath K-5 Efficiently Prioritizes and Adapts Content



MyPath K–5 prioritizes content differently for reading and mathematics. For reading, prioritization centers on comprehension. All Grade K–2 students at or slightly below grade level receive explicit instruction on reading foundations. On-grade or slightly below grade-level students in Grades 3–5 immediately begin with comprehension lessons commensurate with their placement reading level. Students in Grades 3–5 who place at least two grade levels behind begin their ILP with an *Early Literacy Bundle* to review critical foundational skills to accelerate progress toward grade-level comprehension activities. There are three versions of the *Early Literacy Bundle*. Each accelerator bundle includes four lessons focused on phonics, vocabulary, and fluency, with varying complexity based on students' actual grade (which affects presentation style) and placement grade (which affects difficulty level).

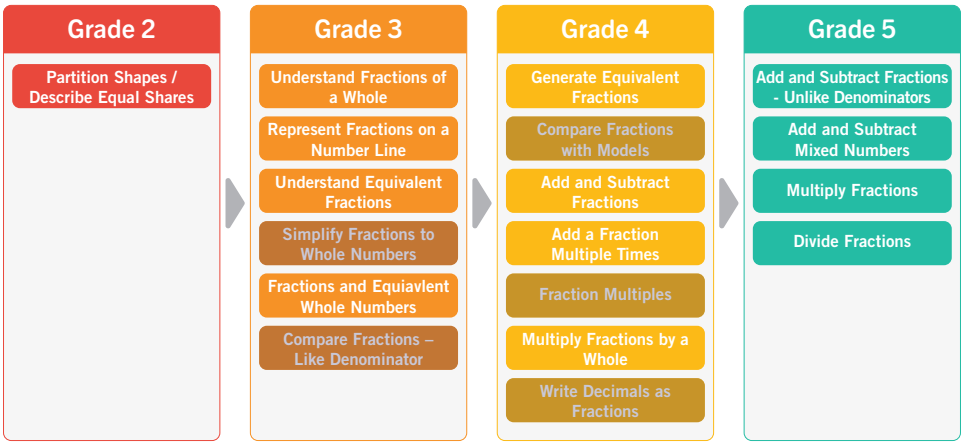


For mathematics, prioritization is domain focused. MyPath K–5 includes lessons across all domains (number and operations, algebra, geometry, measurement, and data), but strongly prioritizes improving students' proficiency with number and operations and algebraic thinking. The program prioritizes rigorous mathematics standards, and includes efficiently mapped progressions of skills designed to maximize students' conceptual understanding of foundational skills to successfully scale them to grade level. These productive learning progressions maximize students' connections across mathematical concepts and the real world, promoting quantitative reasoning across domains.

For example, consider a Grade 5 student operating at a Grade 2 skill level in number and operations (base 10) and a Grade 3 skill level in algebraic reasoning and number and operations (fractions). The student receives an ILP that includes only whole-number concepts at Grade 2, algebra and fractions concepts at Grade 3, and all three domains at the subsequent grade levels. By sequencing and prioritizing lessons by grade, the program builds foundational concepts before moving into more complex skills. Students do not receive all lessons within each domain at the lower grade levels. Instead, the curriculum prioritizes critical content to efficiently scale students back to grade level.

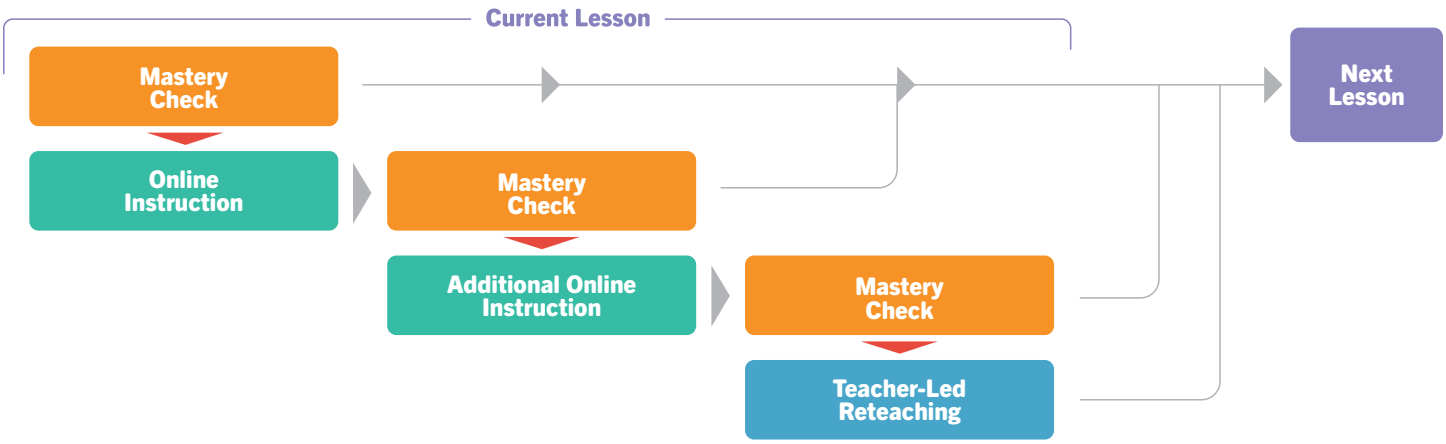
To get a more granular view of how the curriculum prioritizes mathematics content within a specific grade-level skill, consider a Grade 5 student performing three grade levels behind in fractions. The ILP maps complementary skills and reviews critical foundational knowledge required to master the higher-level concept. Progressions become tighter and more efficient. This efficiency accelerates growth to grade-level proficiency.

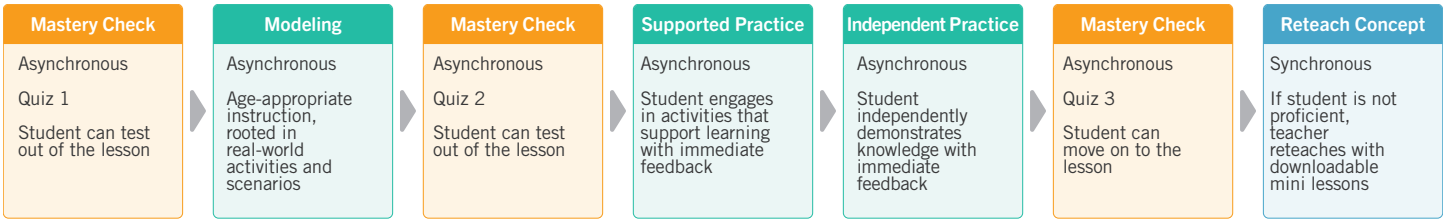
Smart Sequencer™ Efficiently Scales Fifth-Grade Student to Grade-Level Content



MyPath K–5 adapts the curriculum based on students' knowledge and age. Incoming knowledge (based on assessment data) determines the starting point for each student's ILP. Each lesson begins with a five-item mastery check. If a student correctly answers four or more items, they immediately move to the next lesson. If not, they receive video instruction in which an onscreen teacher models the concept, process, or skill. Students have a second chance to pass the mastery check with different items and response options. If they pass, they move on to the next lesson. If not, they receive supported and independent practice with immediate feedback. If a student passes the third mastery check, they move on. If not, the teacher receives a notification that the student requires additional support. The curriculum includes downloadable mini lessons to help teachers reteach the concept and assess students' content knowledge. Students move on when the teacher decides they are ready.

The graphic below shows how MyPath K–5 adapts to students' knowledge within a lesson and the general instructional framework (note that the reading foundations lessons do not follow this exact activity guide).





MyPath K–5's Smart Sequencer™ also adapts the curriculum across lessons. If students display sustained and unproductive struggle, their ILP drops them to the previous domain/grade level. This drop simply recalibrates paths and gives them access to foundational instruction to get them back on track. The same mastery-check rules apply within each lesson. Teachers have the power to adjust ILPs to include critical lessons within and across grade levels to reinforce skills, if necessary. The ILP remains the same, but these additional lessons show up in ILPs the next time they log in to the program.

The curriculum includes a unique library of developmentally appropriate content for struggling students. Students in the upper elementary grades who require skills from lower elementary grades receive modified age-appropriate material (e.g., changes in the graphical presentation, organization, storytelling, context orientation) to be more relevant to their developmental age. For example, students in Grades 3–5 who require lessons in K–2 skills receive a presentation style commensurate with their maturity level, which offers a seamless visual transition from foundational to grade-level content.

For reading, there are three basic style presentations of onscreen text (Grade K–1, Grade 2, and Grades 3–5). Each presentation style (i.e., image use, font size, organization) mimics books and curricula students would typically see at grade level (e.g., flipbooks in kindergarten vs. split screens with more text per page in the upper elementary grades). See Figures 1 and 2 for a sample of presentation style for students in the 3–5 band learning K–2 skills.

For mathematics, there are two basic style presentations (Grades K–2 and Grades 3–5). For example, students in Grades 3–5 whose ILP requires practice with single-digit addition (a kindergarten skill) receive a lesson that includes visual representations commensurate with their age. Rather than receive the same lesson a kindergartener would see (Figure 3), the pictures, instructional models, colors, and layout are modified to be more consistent with actual grade-level materials (Figure 4). Assessment response style also matches students' grade level, regardless of placement level (Figures 5 and 6).

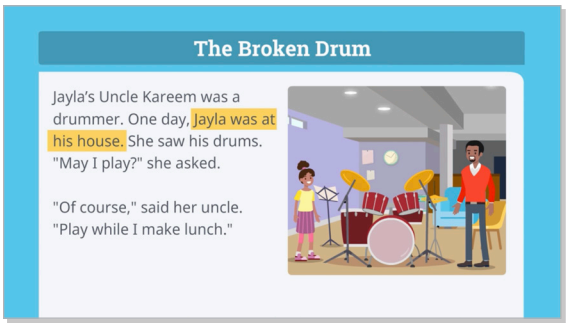


Figure 1. MyPath modifies the passage presentation style for students in the 3–5 band learning K–2 skills.

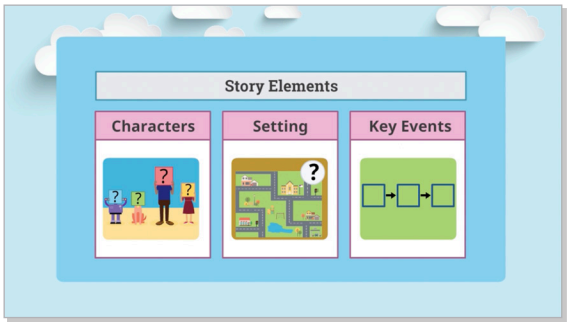


Figure 2. MyPath modifies the presentation style for students in the 3–5 band learning K–2 skills.

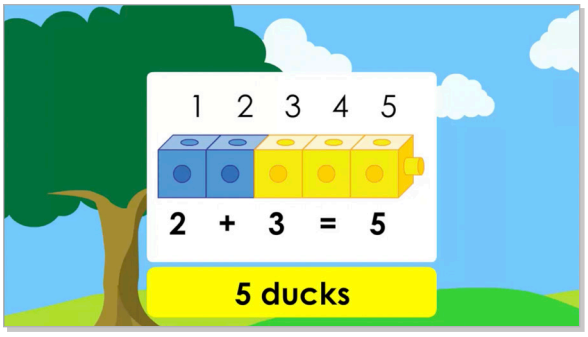


Figure 3. MyPath uses multiple representations to teach whole-number addition.

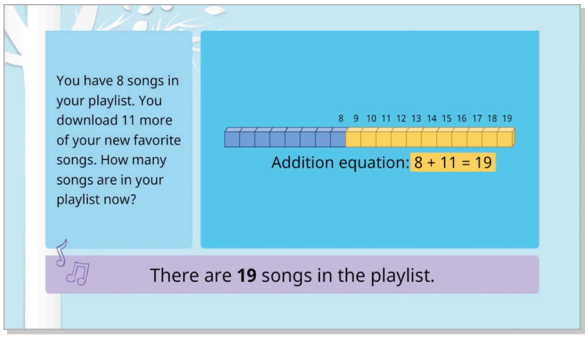


Figure 4. MyPath modifies the manipulative presentation style for students in the 3–5 band learning K–2 skills.

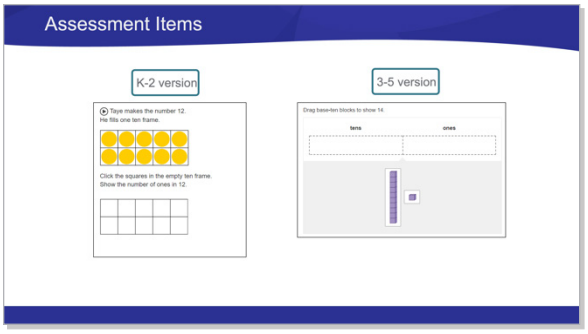


Figure 5. MyPath modifies the presentation style for students in the 3–5 band learning K–2 skills**.**

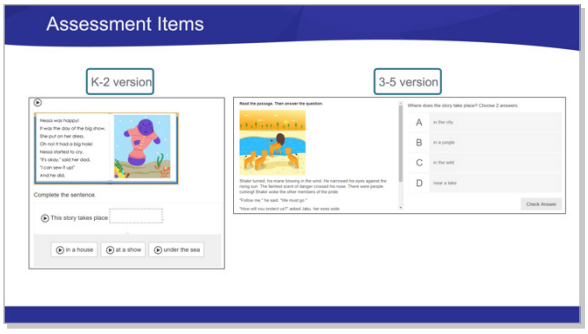


Figure 6. MyPath matches math assessment style to students' grade level, regardless of skill level.

Principle 2: Provide Accessible, Explicit, and Scaffolded Instruction to Ensure Success Among Diverse Learners

Decades of research confirm that providing students with accessible, explicit, and scaffolded instruction leads to greater academic success (Belland et al., 2017; Berkeley et al., 2010; Ehri, 2004; Elleman et al., 2009; Gersten, Chard et al., 2009; Graham & Santangelo, 2014; Hebert et al., 2016; Hudson et al., 2006; Kroesburgen & Van Luit, 2003). The Universal Design for Learning is an evidence-based framework for creating flexible instructional materials and assessments that address students with varying learning needs. This **accessible instruction** aims to reach the widest possible audience by representing instructional information in different ways (e.g., not just relying on a single sense, but illustrating concepts using multiple media), offering students multiple ways of expressing what they know, and encouraging perseverance. To increase engagement, instruction should be relevant, explicit, and designed to minimize distractions. Students should have access to multiple response options to demonstrate understanding, receive scaffolded support, and take charge of their learning with metacognitive goal setting and progress monitoring (Center for Applied Special Technology [CAST], 2018). Rooting problems in real-world contexts makes content clearer and more relevant to learners, especially those at risk for learning difficulties (Bransford et al., 2000; Gersten, Beckmann et al., 2009; Ginsburg et al., 2005; McRel, 2010).

Explicit instruction refers to "a systematic method of teaching with an emphasis on proceeding in small steps, checking for student understanding, and achieving active and successful participation by all students" (Rosenshine, 1987, p. 34). Systematically sequenced, explicit instruction is a pedagogical core teaching practice that spans subjects and disciplines, and makes ambiguous strategies and cognitive processes more transparent and accessible to students, especially those at risk for learning difficulties (Cohen, 2018; Kroesbergen & Van Luit, 2003; Manset-Williamson & Nelson, 2005; McDonald et al., 2013; Rosenshine, 2012; Teaching Works Collective, n.d.). Explicit instruction leverages strategy instruction and adequate support to promote achievement (Archer & Hughes, 2011; Rosenshine, 1987). Explicit instruction includes the following elements (Archer & Hughes, 2011; Fuchs et al., 2008; Konrad et al., 2019; Rosenshine, 2012):

- Use clear and concise language.
- Clearly define lesson goals and expectations.
- Introduce main ideas before details.
- Activate background knowledge before introducing new content.
- Teach a hierarchical progression of critical skills.
- Teach similar strategies and content in isolation before requiring students to differentiate.
- Break down complex skills into manageable chunks to minimize cognitive load.
- Model high-quality thought processes using clear and concise language.
- Guide and support student learning with opportunities for feedback.
- Fade support as students become proficient.
- Provide opportunities for independent practice with immediate corrective feedback.
- Motivate students to sustain attention and work hard.

Instruction should provide audio and visual supports, promote understanding in the student's native language, offer multiple visual representations, activate background knowledge, and guide students in generating ideas (CAST, 2018). This **scaffolding** of instruction (a key principle of explicit instruction) minimizes the learning challenge by decreasing cognitive load (the amount of information someone can hold in their working [short-term] memory at one time), increasing feedback opportunities, and providing a systematic means of scaling students to the learning goal (Archer & Hughes, 2011). Scaffolding boosts achievement in reading (Clark & Graves, 2005), in mathematics (Fuchs et al., 2008), among students with learning disabilities (Gersten, Chard et al., 2009), and among students learning English (Gottlieb, 2013). These supports fade as the learner becomes proficient (Archer & Hughes, 2011).

Computer-based scaffolding effectively boosts learning by making use of technology to apply pedagogical rules to calibrate and individualize instruction to support students' understanding of complex concepts and problem-solving skills in real time (Molenaar & Roda, 2008). In a meta-analysis of 144 studies isolating the effects of computer-based scaffolding in STEM (science, technology,

engineering, and mathematics) topics, Belland et al. (2017) found a significantly positive effect across content areas and learner types. Research also supports adapting the presentation of material across content areas to support learning (Ma et al., 2014; VanLehn, 2011). Effective scaffolding incorporates explicit strategy instruction with multiple demonstrations and an array of interactive (discussions, using native language), sensory (illustrations, manipulatives), and graphic (graphic organizers, number lines) supports (Archer & Hughes, 2011; Gottlieb, 2013).

Interactive scaffolds strengthen students' listening and comprehension skills to make sense of new ideas (Gottlieb, 2013; Sweller, 1988). For example, research suggests that incorporating interactive opportunities within multimedia storybooks boosts students' knowledge of speech sounds, concepts about print, and reading comprehension (Shamir & Shlafer, 2011; Takacs et al., 2015). For English-language learners, interactive scaffolds, such as teaching complex topics in a student's native language, can reduce cognitive load and improve achievement (Gotlieb, 2013; Orosco, 2013).

Sensory scaffolds support the acquisition of new knowledge through narratives and visual connections across ideas (Gottlieb, 2013). But because the brain independently processes audio and visual information, sensory scaffolds must not distract students (Sweller 1988). For example, digital instruction should incorporate narration (rather than onscreen text) to describe the visuals and to reduce cognitive load (Mayer & Moreno, 1998). Illustrations, combined with narrated questioning, paint a vivid picture to support reading comprehension (Clark & Graves, 2005). The concrete-representational-abstract (CRA) approach (Brunner & Kenney, 1965) has a longstanding history of effectively scaffolding conceptual understanding across a range of mathematics topics because it allows students to visualize complex topics with models and pictures before learning algorithms (Hudson & Miller, 2006).

Graphic scaffolds visually organize information so students can recognize relationships, patterns, outliers, etc. (Gottlieb, 2013). For example, Frayer Model graphic organizers support vocabulary acquisition in reading (Dexter & Hughes, 2011; Frayer et al., 1969; Gajria et al., 2007). Number lines enhance students' magnitude understanding in mathematics (Gersten et al., 2017; Namkung & Fuchs, 2019).

How MyPath K–5 Provides Accessible, Explicit, and Scaffolded Instruction to Ensure Success Among Diverse Learners

MyPath K–5 provides **accessible** instruction for diverse learners, consistent with the Universal Design for Learning framework, and incorporates the principles of **explicit instruction**. Computer-based adaptivity matches students' unique learning needs, tailoring instruction to efficiently propel them to grade level and beyond. Students show what they know in a variety of ways, with question-response formats that include multiple choice, drag and drop, free-writing responses, charts, graphic organizers, and virtual manipulatives. Clear goals and expectations, data dashboards, and positive behavioral support with digital rewards (e.g., points, badges) and customizable features (e.g., sidekicks, custom backgrounds) help students monitor their progress and persevere through their ILP. Short, laser-focused lessons feature real-world examples and relevant visual supports to increase engagement. Lessons mimic in-person conversation with clear, dynamic, enthusiastic language. Onscreen teachers pause after asking questions to give students an opportunity to respond.

Students learn a range of strategies for solving problems (e.g., various approaches to word-problem solving). Onscreen teachers model metacognitive strategies, so students see how they should apply them during reading or problem solving. For example, to model how to use clues to figure out what words mean, the onscreen teacher preps students by telling them, "Pause and identify words you don't understand, then ask yourself: What does this word mean? Look for context clues in the words and pictures… Put the words and the clues together and come up with your own meaning of the words…then check whether this makes sense." The teacher models how to apply these metacognitive strategies while reading a book about bugs. She frequently stops and models how to check her understanding as she reads. In a mathematics lesson, the onscreen teacher models how to check the reasonableness of the answer to a multidigit addition problem using base 10 blocks and the number line.

Other **interactive scaffolds** include hyperlinked vocabulary words, metacognitive bubbles to support strategy use, and text-to-speech capabilities. Onscreen text can be translated into 62 languages, including Arabic, Bengali, Chinese, French, German, Hebrew, Hindi,

Hmong, Korean, Kurdish, Russian, Spanish, Swahili, and Vietnamese. Every mathematics lesson includes a corresponding lesson in Spanish (Figures 7 and 8), scaffolding students from their native languages to ensure they do not get further behind. Students can watch the lesson in Spanish and then in English, simultaneously boosting content knowledge and biliteracy. Guided and independent practice includes answer-specific feedback that intentionally addresses common misconceptions, engages students in an explanation about why an answer is incorrect, and offers strategies to help them find the correct answer.

For example, in a reading lesson about how to identify the topic, main idea, and key details, students read a passage about kids starting a business and select which summary statement depicts the topic. The responses include information discussed in the passage that does not reflect the main topic. When a student answers incorrectly, narrated corrective feedback discusses why their response is incorrect and offers strategies for selecting the correct answer (e.g., "While the text did mention making honey, the whole text is not about making honey. Remember, the topic is what the whole text is about."). The onscreen teacher tells the student to reread the title and the first paragraph to determine the topic.

Multiple modes of representing information (i.e., **sensory scaffolds**) within the same lesson (e.g., combinations of video and audio or text and narration, multimedia support, icons, mathematics manipulatives) enhance learning. Technology enhances the learning experience with immediate transformation and visualization. For example, it is cumbersome to break up and combine base 10 blocks, but technology allows this to occur instantaneously, increasing conceptual understanding and minimizing distractions during learning. Students can pause and rewind videos and repeat videos or lessons, if needed. Onscreen arrows, highlighting, circling, and pointing reinforce concepts through an interactive narrative. Audio and visual examples and non-examples, animations, vivid storytelling, and multimedia representations support comprehension and conceptual understanding. For example, a reading lesson demonstrates how visuals and multimedia supports can help add to the meaning, tone, and beauty of the text, much like pictures in a graphic novel. Students discuss how media (e.g., charts, graphs, illustrations, videos) can enhance expository and narrative texts, with various examples (e.g., students discuss how a picture of Zeus's face demonstrates how angry he is with his sons Prometheus and Epimetheus).

The curriculum utilizes a wide range of **graphic scaffolds**. Graphic organizers (e.g., concept maps, T-charts, Venn diagrams, sequential graphics, timelines) help students highlight important ideas, compare and contrast concepts, represent relationships, depict chronology, and illustrate cause and effect. For example, in an expository text lesson, the onscreen teacher narrates a story during a multimedia simulation of a bird catching its prey to introduce domain-specific vocabulary words (Figure 9). In the same lesson, the teacher uses a graphic organizer to organize a word's definition, illustration/characteristics, and examples and non-examples to enhance word learning and reading comprehension (Figure 10). The onscreen teacher discusses how variations of the word (e.g., adapt vs. adaptation) affect word meaning, but that word roots help us figure out the meaning of more challenging words. Number lines support whole-number (Figure 11) and fraction-magnitude knowledge (Figure 12) in mathematics.

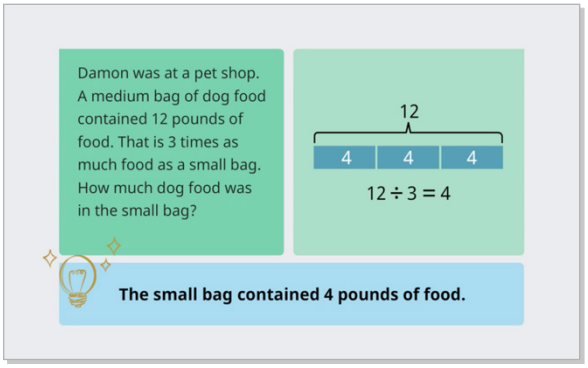


Figure 7. Students in the 3–5 band learn to divide using models.

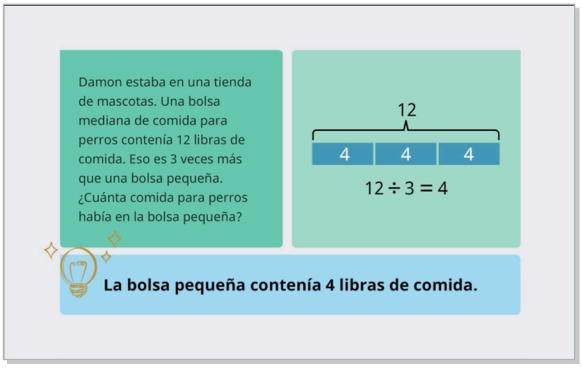


Figure 8. Spanish-speaking students in the 3–5 band learn to divide using models.

Figure 9. Students in the 3–5 band learn domain-specific vocabulary words using multimedia supports.

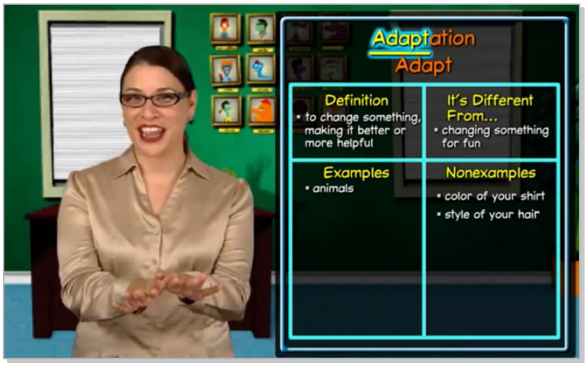


Figure 10. Students in the 3–5 band use graphic organizers to reinforce vocabulary instruction.

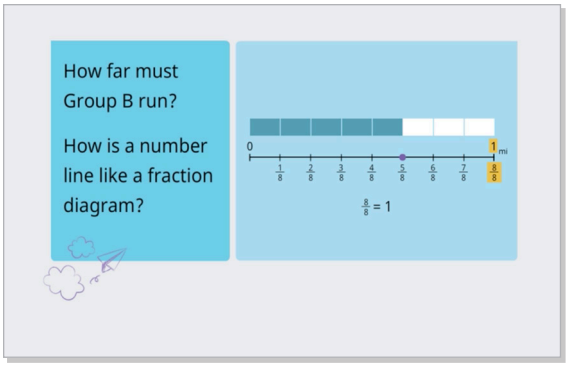


Figure 11. Students in the 3–5 band learn about elapsed time using number lines.

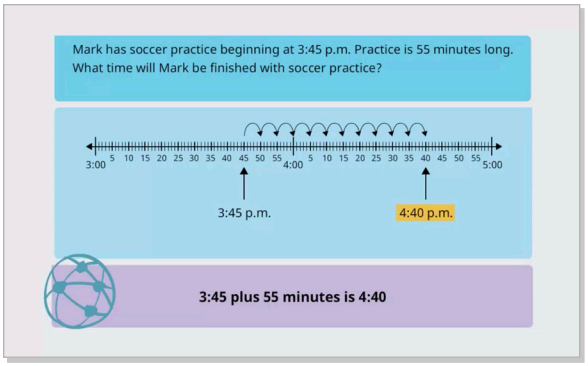


Figure 12. Students in the 3–5 band learn about fraction concepts using number lines.

A sample mathematics lesson on reading and writing multidigit numbers can further illustrate how MyPath K–5 incorporates the principles of explicit instruction. The onscreen teacher uses clear and concise language, consistent with students' developmental ages, to review relevant vocabulary (e.g., "written form," "standard form," "expanded form") and defines lesson goals: "Today we're going to learn how to write numbers in written, standard, and expanded form to 1,000,000." He then introduces a real-world, engaging example to ensure students understand the main idea before learning the details. The teacher describes how reading and writing multidigit numbers in different ways (main idea) can help them describe facts about their home state (Figure 13). The video shows Darrius (a student) learning how to write the area (65,758 sq mi) of Florida in written, standard, and expanded form (Figures 14 and 15). This introduction activates students' background knowledge before the lesson iteratively connects this knowledge to a review of the learning objectives. The teacher introduces a hierarchical progression of critical skills by explicitly reviewing "what you know" by modeling writing multidigit numbers to the thousands place (Figure 16), ten-thousands place (Figure 17), and hundred-thousands place (Figure 18) before scaling students to the learning goal. This breakdown of complex skills into manageable chunks scaffolds learning, reduces cognitive load, and adequately prepares students to tackle the learning goal. The teacher presents each skill in isolation before expecting students to differentiate and apply their knowledge. Concrete models, narration, and highlighting of text support understanding.

During guided practice, students practice the new skill with various multimedia response options (e.g., multiple choice, drag and drop), access to audio support if needed, access to a glossary of relevant terms (Figure 19), and hints if they get stuck. Immediate corrective feedback features different audio dings and visual cues (green checkmark vs. red X) to distinguish correct from incorrect answers. If the student answers correctly, the narrator reviews the answer (Figure 20). If the student answers incorrectly, the program allows the student to try again before offering corrective feedback that is specifically designed to address common misconceptions. Support fades as the student demonstrates proficiency. With each mastery check, students have the opportunity

to earn stars (rewards) to motivate them to sustain attention and work hard. Independent practice parallels guided practice with immediate corrective feedback, but the student has only one try per item. Feedback reinforces the correct answer or explains why the response was incorrect. If students fail their final mastery check, the teacher provides instruction offline. Offline instruction is also explicit and provides teachers with answer guides to help them address common misconceptions.

Figure 13. Students in the 3–5 band learn the importance of writing numbers in different ways.

Figure 14. Students in the 3–5 band see the utility of writing numbers in standard form.

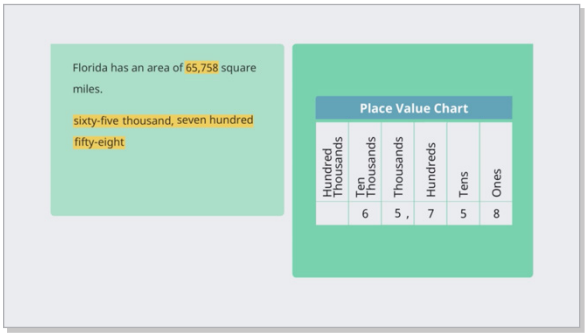


Figure 15. Students in the 3–5 band use a place-value chart to write numbers in standard and written form.

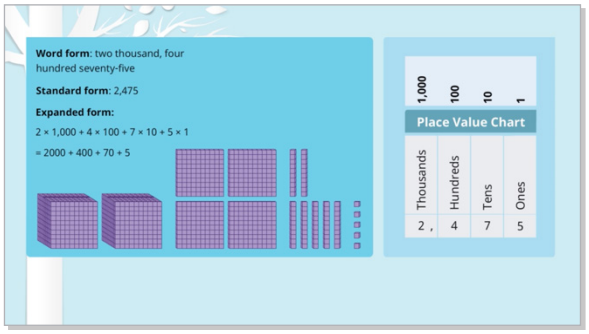


Figure 16. Students in the 3–5 band use 3D models to support place-value understanding.

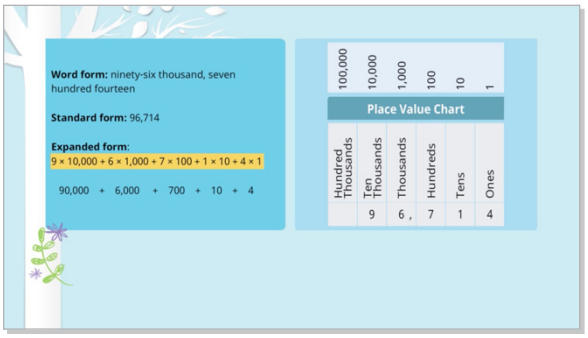


Figure 17. Students in 3–5 band activate background knowledge by reviewing previously learned skills.

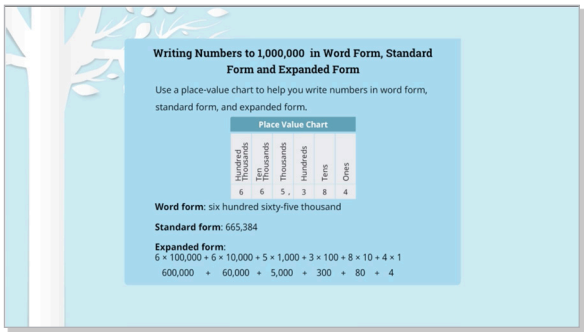


Figure 18. Students in the 3–5 band review background knowledge before scaling to the learning goal.

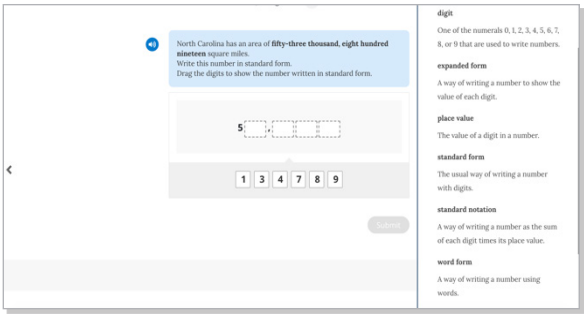


Figure 19. Students have access to math glossaries to support mathematics vocabulary development.

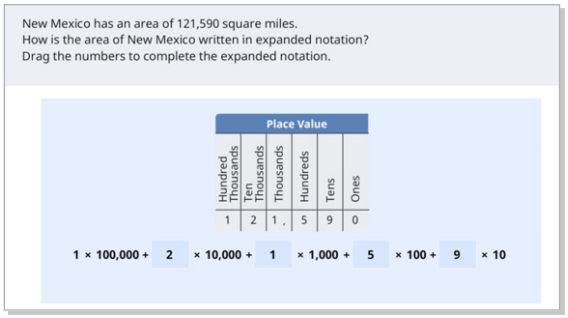


Figure 20. Students receive corrective feedback focused on common misconceptions and errors.

MyPath K–5 also integrates downloadable offline teaching materials to use with individual students, small groups, or the whole class if one or more students consistently struggle with a concept (i.e., fails all three master checks within a lesson). Each of these scaffolded reteaching lessons includes a student-facing worksheet and an answer key. The lesson includes a review of the concept, guided practice (a reading passage in reading and a "try it" section in mathematics), independent practice, and opportunities to demonstrate understanding and receive immediate feedback from the classroom teacher. The review section strategically uses icons, graphic organizers, bullets, bolded words, and other text features to help students quickly access pertinent information (e.g., an "anchor chart" students can reference).

Guided practice isolates the specific skill(s) with which the student struggles with and incorporates scaffolded support (e.g., a partially worked example). For example, reading passages do not include extraneous challenges, such as difficult vocabulary or the need to draw inferences and conclusions when those are not the targeted skills. Metacognitive bubbles model self-questioning strategies students can use when they encounter similar passages/problems. For example, a metacognitive bubble reminds students to ask themselves to identify the main idea while reading the introductory paragraph of a passage.

Students then independently practice the concept reviewed with scaffolded support. Each question strategically moves students through the problem-solving process until they have uncovered all the necessary information to answer the skill question. Questions are clear and concise; they are not tricky. Each reteaching lesson ends with an open-ended prompt that allows students to demonstrate their understanding of the skill in a discussion or journal. Like an "exit ticket," this question often prompts students to summarize the main takeaway. Student responses allow the teacher to determine whether a student has mastered the skill and can transfer their knowledge to more complex tasks, or if the teacher needs to provide additional support.

Principle 3: Incorporate Evidence-Based Practices for Teaching Reading

Reading comprehension, the ability to derive and formulate meaning from text, is a complex and iterative process requiring simultaneous processing of code-based (reading) and meaning-based (extracting meaning) skills (Gillon, 2018; Scarborough, 2001; Torgesen, 2002). As students improve their word-reading ability, they extract greater meaning from text, which improves their ability to derive meaning from more complex texts. Instruction must be direct and systematic, and must logically progress from one skill to another to improve code- and meaning-based skills (Boyer & Ehri, 2011; Gersten, Compton, et al., 2009; National Institute of Child Health and Human Development [NICHD], 2000; Ryder et al., 2008). Poor code-based skills predict poor meaning-based skills, including reading fluency, vocabulary, and reading comprehension (Hudson et al., 2012; Torgesen, 2002). In a meta-analysis of more than 450 studies, Hammill (2004) concluded that the strongest predictors of reading achievement were code-based skills associated with print, including how letters, words, sentences, and books function (print awareness); knowledge of letters (alphabetic principle); knowledge of letter-sound correspondences (phonics); and ability to read and recognize words (decoding). Lessons should provide explicit and systematic instruction in each of these written language abilities to lay the foundation to develop fluent comprehenders (NICHD, 2000).

Code-Based Skills

Code-based skills refer to the mechanics of reading required to accurately and effortlessly decode words in print (Gillon, 2018; Torgesen, 2002). To "break the code," students must connect oral language to text and understand how sounds, letters, words, and sentences work together to create meaning (Chall, 1983; Gillon, 2018). Because there are only 26 letters and 44 letter sounds (phonemes), data indicate that "code-based skills are discrete and highly susceptible to instruction in a relatively brief period" (Lesaux & Harris, 2015, p. 12). Research shows the following code-based skills are critical to reading comprehension (NICHD, 2000; Torgesen, 2002):

- Print awareness and the alphabetic principle
- Phonological and phonemic awareness
- Phonics
- Decoding and word reading

Print Awareness and the Alphabetic Principle

Before entering elementary school, children develop understanding of print concepts (i.e., how letters, words, sentences, and books function) through immersive storybook reading (Chall, 1983). This **print awareness** supports vocabulary development and knowledge of the **alphabetic principle** (the relationship between sounds, letters, and text), which positively affects later reading achievement (National Early Literacy Panel, 2008; Robinson et al., 2018; Stanovich, 1986). Students enter school with a range of skills. Instruction should, therefore, explicitly and systematically teach students book-reading mechanics, the mechanics of written text, identifying letters in words, and matching lowercase and uppercase letters (NICHD, 2000; Robinson et al., 2018).

How MyPath K–5 Develops Students' Print Awareness and Knowledge of the Alphabetic Principle

Lessons occur in text, rather than in isolation, to boost students' transfer to comprehension. Immersive storybook reading teaches book-reading mechanics. For example, students learn how to locate the front and back of a book, that the front of the book includes the names of the author and illustrator, and that book reading requires tracking words from left to right, top to bottom, and page by page. After reading storybooks, students review the concepts with highlighting, arrows, and visuals to reinforce these skills (Figure 21). Lessons explicitly teach sentence structure. For example, words compose sentences (with spaces between words), sentences begin with a capital letter, and sentences require punctuation (Figure 22). Lessons emphasize recognizing and counting individual letters (Figure 23), introducing shapes of letters, and practicing matching lowercase and uppercase letters (Figure 24).

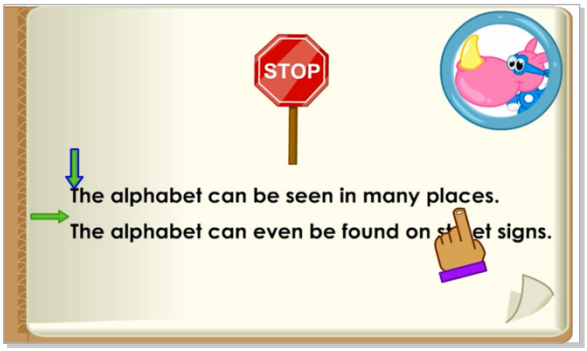


Figure 21. Visuals reinforce book reading for students in the K–2 band.

Figure 22. Students in the K–2 band learn sentence structure.

Figure 23. Students in the K–2 band learn to identify letters in a word.

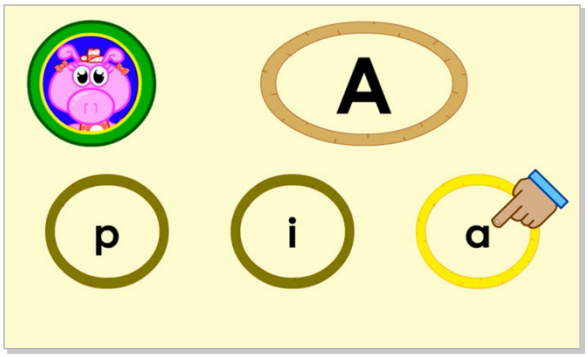


Figure 24. Students in the K–2 band practice matching lowercase letters to uppercase letters.

Phonological and Phonemic Awareness

Phonological awareness refers to the ability to orally break down language into smaller parts, such as words, syllables, onsets, and rimes (Gillon, 2018; Stanovich, 1986). Onsets refer to the consonant before the vowel in a syllable (e.g., /b/ in back). Rimes are the vowel-consonant word part that follows the onset (e.g., /ack/ in back). The ability to hear, identify, and manipulate individual speech sounds, called **phonemic awareness**, is one of the strongest predictors of students learning to read (Ehri et al., 2001; Shaywitz & Shaywitz, 2003; Snow et al., 1998). In fact, "a deficit in phonology represents the most robust and specific correlate of reading disability" (Shaywitz & Shaywitz, 2003, p. 159). It predicts difficulty with developing the critical skills associated with print (Hudson et al., 2012). Phonological and phonemic awareness training is a complex, stepwise process, and should explicitly teach students to (Allor et al., 2006; Al Otaiba et al., 2016; Gillon, 2018; International Dyslexia Association, 2018; NICHD, 2000; Schuele & Boudreau, 2008; Shaywitz & Shaywitz, 2003):

- Identify and generate rhymes and alliteration.
- Understand that words compose a sentence.
- Understand, identify, and segment syllables.
- Match words with their initial and final sounds.
- Segment and blend onsets and rimes.
- Identify phonemes.

Instruction should focus on words that are familiar to students. Incorporating pictures, sounds, and contextual meaning in these activities provides concrete scaffolds for students to rely upon (Al Otaiba et al., 2016).

How MyPath K–5 Develops Students' Phonological and Phonemic Awareness

To reinforce rhymes, students match pictures to spoken words (e.g., matching "rat" to "hat," Figure 25). Lessons include storybooks and sentences with alliteration (e.g., "Mel moose makes a map," Figure 26). To emphasize that words compose sentences, lessons incorporate non-examples of sentences (Figure 27) to scaffold students from a basic understanding of print before introducing sentence rules (Figure 28). These sentence rules include: words compose sentences, capitalize the first letter of

the first word, and end the sentence with punctuation. A green light shows students they start with the capitalized word, and a red light indicates the punctuated end of the sentence. These prompts support students' reading fluency.

To help students understand, identify, and manipulate syllables, students see a picture and a contextualized sentence before counting out syllables with Elkonin boxes. In this example, students hear /fea/ /ther/ and match the counters with the number of boxes (Figure 29). Students play games to practice matching words with their initial and final sounds. Once proficient, they scaffold these target sounds to a storybook that incorporates the familiar practiced words (e.g., "bug") and pictures to support contextual meaning (Figure 30). To practice blending onsets and rimes within consonant-vowel-syllable words, students hear the word parts (e.g., /l/ /og/) and match the sounds to the blended word (e.g., "log"). Students click on multiple choices to hear the blended word, and must choose the correct answer. Students also practice adding onsets to rimes to make new words. For example, students see a picture of an ape and learn to add the /c/ sound to make "cape" (with a corresponding picture). Immersive storybook reading helps students identify individual phonemes in words (e.g., "d" is for dinosaur).

Figure 25. Students in the K–2 band practice matching pictures (e.g., "rat") to spoken words (e.g., "hat").

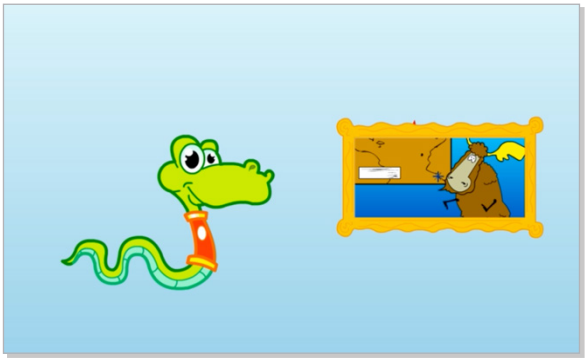


Figure 26. Students in the K–2 band hear alliterated stories (e.g., "Mel moose makes a map.").

Figure 27. Students in the K–2 band learn about sentence structure with a non-example.

Figure 28. Students in the K–2 band learn about sentence structure with a correct example and visual support.

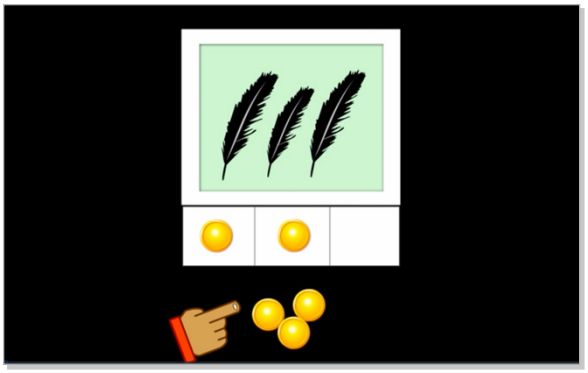


Figure 29. Students in the K–2 band use Elkonin boxes to practice syllable counting (e.g., /fea/ /ther/).

Figure 30. Students in the K–2 band listen to a storybook reinforcing onsets and rimes (e.g., "bug").

Phonics

Phonemic awareness and knowledge of letter-sound correspondences (phonics) are the two strongest predictors of early reading skill (Muter et al., 2004). Therefore, instruction should connect sounds to letters as soon as developmentally appropriate (Ehri et al., 2001; Yeh & Connell, 2008). **Phonics** refers to the process of connecting phonemes to graphemes (letters), including connecting and analyzing larger word subparts (NICHD, 2000). Students who receive explicit and systematic phonics instruction have better decoding skills than those who do not (Allor et al., 2006; Al Otaiba et al., 2016; Denton & Madsen, 2016; Edmonds et al., 2009; Ehri et al., 2001; Foorman et al., 2003; Schuele & Bourdreau, 2008).

Decoding requires converting letters (or groups of letters) into sounds and blending them to form words. Instruction should emphasize blending and manipulating phonemes with letters (NICHD, 2000). Because words can vary by a single phoneme (e.g., "bug" vs. "bag"), phonics instruction should attend to how these distinctions affect word meaning (Lonigan, 2007; Metsala & Walley, 1999). Explicit attention to phonemic distinctions improves vocabulary and spelling (Ehri, 2004; NICHD, 2000).

Explicitly teaching **subunit phonics**—emphasizing analyzing word subparts that recur across words—and sight words (words that are difficult to decode) improves students' decoding skills (Hudson et al., 2012; NICHD, 2000). Subunit phonics include a focus on phonograms (multiple letters representing one sound, e.g., /ould/), digraphs (two letters representing one sound, e.g., /sh/), and rimes. Because 37 common rimes comprise most students' early word reading (Wylie & Durrell, 1970), recognizing these letter patterns is critical for decoding. Hudson et al. (2012) found that students' fluency with recognizing rimes predicted their decoding skill above and beyond other code-based skills, likely because rime fluency combines lower-level skills and allows students to efficiently decode words in chunks, rather than letter by letter. Their findings highlight the importance of teaching word families (e.g., multiple words with the same rime) to improve students' decoding skills.

Because word subunits also dictate spelling patterns, teaching these patterns can assist students' proficiency with spelling (Ehri, 1999). Furthermore, explicit instruction on common irregular spelling patterns (e.g., /ould/) improves students' phonological awareness, spelling skills, writing ability, and overall reading ability (Graham & Santangelo, 2014). Students should always practice applying code-based skills within connected text (Foorman et al., 2016). Careful annunciation and visual support are critical aspects of effective phonics instruction (Carreker, 2018). Older struggling students should receive explicit phonics instruction (Edmonds et al., 2009; Gersten, Compton, et al., 2009).

How MyPath K–5 Develops Students' Understanding of Phonics

MyPath K–5 strongly emphasizes phonics to solidify the skills needed to read connected text. Phonics lessons scale students' phonemic awareness by blending and manipulating phonemes with letters. The onscreen teacher models how to "blend the sounds in order" (e.g., blend the consonant-vowel-consonant in the word "run," Figure 31). Pictures always support phonics activities to enhance understanding (Figure 32). Students practice manipulating phonemes to form new words. For example, a silly illustration emphasizes the phonemic distinction between "bug" and "bag" (Figure 33). Students hear annunciated phonemes and practice making these distinctions with connected text. For example, the onscreen teacher highlights the phonemic distinction between "hall" and "fall" to emphasize the onset and rime within connected text to improve decoding ability (Figure 34).

There is a strong emphasis on subunit phonics and recognizing sight words. Lessons focus on word families to improve students' decoding skills. For example, students learn to identify onset distinctions among words with the /at/ rime (e.g., cat, bat, rat, hat, Figure 35). Word-family lessons incorporate pictures, Elkonin boxes, pointers, and highlighting to emphasize the onset and rime to reinforce recognition of these common rimes (Figure 36). Onscreen teachers explicitly teach students how to blend digraphs (Figure 37), common vowel pairs (e.g., /ea/), and common consonant blends (e.g., /br/). Word-family lessons include tricky words with common irregular spelling patterns such as /ight/, /ing/, and /ould/ (Figure 38). For example, students practice reading and matching words with irregular spelling patterns (e.g., could, would, should) and explicitly differentiate them from words with the /ou/ sound, such as "wound," "hound," etc. In guided practice, students match words with those spelling patterns within cloze passages. Audio supports students' word recognition. Students then scale their knowledge of word parts to decoding multisyllabic

words (Figure 39). To provide explicit connections between code- and meaning-based skills, lessons emphasize phonics within connected text. For example, after learning the /ing/ spelling pattern, students read a story (Figure 40) emphasizing words with /ing/ (e.g., “king,” “sing”). Highlighting of the onscreen text builds automaticity with sight words. Teachers model correct annunciation and fluent intonation.

The three *Early Literacy Bundles* include age-appropriate lessons emphasizing the following phonics skills (note *Bundle 1* is for Grade 2 students who place in kindergarten; *Bundle 2* is for Grades 3–5 students who place in Grades K–2; *Bundle 3* is for Grade 5 students who place in Grade 3):

- Identify long and short vowels in single (*Bundle 1* and *Bundle 2*) and multisyllabic words (*Bundle 3*).
- Identify syllables in multisyllabic words (*Bundle 1* and *Bundle 2*); decode multisyllabic words (*Bundle 3*).
- Decode multisyllabic words in sentences (*Bundle 1*, *Bundle 2*, and *Bundle 3*).

Note that the rigor, complexity, and Lexile band advances with each bundle to be more relevant to the student’s actual grade.

Figure 31. Students in the K–2 band learn the importance of blending individual sounds in order.

Figure 32. Students in the K–2 band learn to blend consonant-vowel-consonant words (e.g.,“run”).

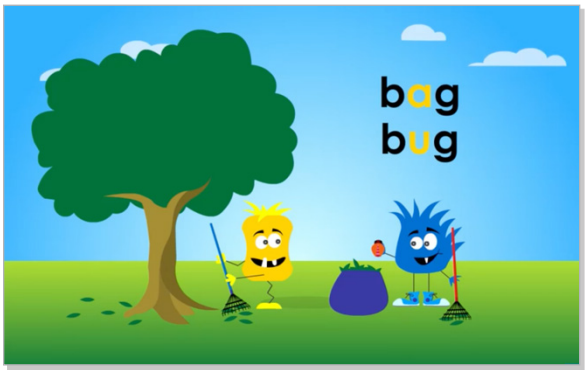


Figure 33. Students in the K–2 band hear a silly story to emphasize phonemic distinctions.

Figure 34. Students in the K–2 band hear reading of connected text to emphasize phonemic distinctions.

Figure 35. Students in the K–2 band learn to differentiate words with a common rhyme.

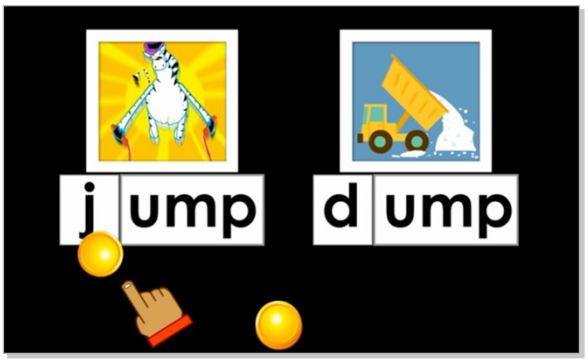


Figure 36. Students in the K–2 band use Elkonin boxes to identify and emphasize onsets and common rhymes.

Figure 37. Students in the K–2 band hear how to blend digraphs.

Figure 38. Students in the K–2 band learn to decode words with common irregular spelling patterns.

Figure 39. Students in the K–2 band practice decoding multisyllabic words with visual support.

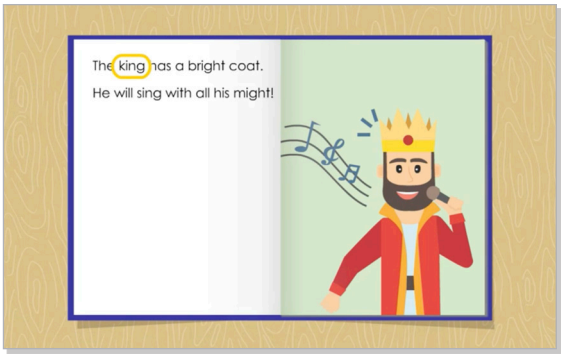


Figure 40. Students in the K–2 band practice decoding common irregular words in connected text.

Meaning-Based Skills

As students' code-based skills become increasingly automatic, they free up working memory capacity to apply meaning-based skills to comprehend text (Scarborough, 2001; Torgesen, 2002). **Meaning-based skills** comprise the range of abilities and knowledge necessary for comprehending text. These skills include: strong academic and domain-specific vocabulary; the ability to read with purpose and understanding (fluency); knowledge of concepts about the world (background knowledge); the ability to understand and express ideas (text structures); and the ability to flexibly apply comprehension strategies to understand the text. Research shows that explicit and systematic instruction in these skills improves reading comprehension (Boyer & Ehri, 2011; Carlisle & Rice, 2002; Marzola 2018; NICHD, 2000; RAND Reading Study Group, 2002; Ryder et al., 2008; Torgesen & Hudson, 2006; Wagner & Meros, 2010).

Vocabulary

Vocabulary refers to the words we must know to communicate effectively (speaking and listening) and comprehend text (reading and writing). Vocabulary "serves as the bridge between the word-level processes of phonics and the cognitive processes of comprehension" (Kamil & Hiebert, 2005, p. 4). Vocabulary and comprehension have a reciprocal relationship (Stahl & Nagy, 2006; Stanovich, 1986). Boosting students' vocabulary boosts their comprehension of complex texts, which provides richer context by which students can access their background knowledge and make inferences to understand text (Elleman et al., 2009; Stahl & Nagy, 2006). This rich context begets academic and domain-specific vocabulary acquisition, increasing students' fluency and reading comprehension (Torgesen & Hudson, 2006). Research suggests explicitly teaching the following to boost students' vocabulary:

- **Emphasize morphology and irregularities in the English language**. Morphological awareness refers to attending to the smallest unit of meaning in words (morphemes). Morphemes can be bound (e.g., "lunch" in lunchbox) or free (e.g., "*un*" in unkind). Like teaching subunit phonics, emphasizing morphology unlocks students' decoding skill, vocabulary knowledge, ability to infer the meaning of unfamiliar words, and spelling ability (Carlisle, 2010; Joshi, 2016). Improved decoding skill frees up working

memory capacity for comprehension (Carreker, 2018; NICHD, 2000; Scarborough, 2001; Strom & Neuman, 2016; Swanson et al., 2017; Torgesen, 2002).

- **Identify context clues**. Instruction on morphology, combined with teaching students how to identify context clues (hints within the text to uncover the meaning of unfamiliar words), improves comprehension, especially among students with reading disabilities (Brown et al., 2016; NICHD, 2000; Toste et al., 2017).
- **Provide explicit instruction on academic and domain-specific words**. Formal instruction should extend students' vocabulary knowledge from words commonly used in oral language to academic and domain-specific words (NICHD, 2000). Academic vocabulary refers to words commonly read in academic texts, such as in the arts, commerce, law, and science. Domain-specific vocabulary refers to technical words directly related to the field of study (Beck et al., 2013).
- **Explicitly teach concept mapping**. Graphic organizers support vocabulary acquisition (Dexter & Hughes, 2011; Frayer et al., 1969; Gajria et al., 2007; NICHD, 2000).
- **Provide a rich context for vocabulary development**. A rich context helps students understand unfamiliar words, including multiple learning opportunities, various types of text, student-friendly definitions, and supported audio and visuals (NICHD, 2000; Swanson et al., 2017).
- **Provide repeated exposure**. Repeated reading of complex text facilitates practice in noting challenging words, replacing the challenging word with a synonym, and checking for understanding to boost comprehension (Toste et al., 2017). This repeated exposure fosters vocabulary development (Beck et al., 2013; NICHD, 2000).

How MyPath K–5 Develops Students' Vocabulary

Lessons emphasize how **morphology** affects word meaning to help students uncover word meaning and improve reading comprehension. For example, students learn the meaning of common prefixes (e.g., pre-) and suffixes (e.g., -ful), and apply this knowledge to unfamiliar words by looking at the base word combined with the affix (Figure 41). Students also learn that word roots (e.g., graph, photo, tele, auto) are one kind of word part and may come from other languages, such as Latin or Greek. Students learn that the meaning in these languages helps them figure out unknown words and spell them. For example, students learn the root "graph" means "to write or draw." Students apply this knowledge to figure out the meaning of words such as "paragraph," "biography," etc. (Figure 42). Affix instruction first occurs in isolation, then students apply their knowledge with connected text to foster vocabulary development. The three *Early Literacy Bundles* emphasize morphology to understand words, increasing rigor, complexity, and Lexile band with each bundle.

Onscreen teachers use real-life examples to introduce **context clues**. For example, a teacher engages students by likening identifying nonfiction context clues to seeing a cat purr and knowing it is happy even though you cannot ask the cat why it is happy: "You put together clues plus what you already know to figure out that a cat purrs when it is happy. Did you know that we think like this when we read? We can use what we already know to figure out something new!" The supporting video and visuals prime students to make inferences when reading to understand the topic. Students then practice using clues, (e.g., "Look for clues in the surrounding text or pictures.") to make inferences in an engaging book about making pizza: "The book does not say why Dad wears gloves when he makes pizza, but we can infer that he wants his hands and the pizza to stay clean." Interactive visuals, highlighting, and pictures support students' understanding. Guided practice requires students to identify words and phrases to help them make inferences.

Students also learn to use context clues to extract meaning by identifying a word's definition, a synonym/antonym, or an example. Narrative text instruction focuses on figurative language (including similes and metaphors), multiple word meanings, and challenging vocabulary (Figure 43). For example, students use context clues to figure out the meaning of similes and metaphors in figurative language (Figure 44). Metacognitive bubbles remind students to apply the strategies while they read.

Vocabulary instruction strongly emphasizes uncovering the meaning of **academic and domain-specific words** and phrases required for reading, writing, speaking, and listening at grade level and beyond. For example, students listen to a story about predators, prey, and adaptation (with multimedia support) and use graphic organizers to map out the definition, examples/non-examples, etc. The onscreen teacher emphasizes that the suffix *-tion* in "adaptation" creates an action (i.e., the process of adapting). Vocabulary

development occurs in a **rich context** with multiple learning opportunities, **repeated exposure** across various narrative and expository texts, vivid visuals, student-friendly definitions, modeling strategy use across text, and teacher-led discussions. The onscreen text incorporates audio, music, and pictures to increase students' semantic mapping of new words. Highlighting relevant text emphasizes strategy use (e.g., using morphology and context clues to uncover word meaning). Students can hover over challenging academic and domain-specific words to read definitions and check for understanding in longer passages.

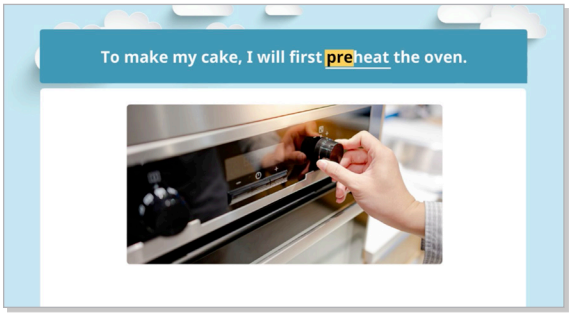


Figure 41. Students in the 3–5 band learn the meaning of common prefixes.

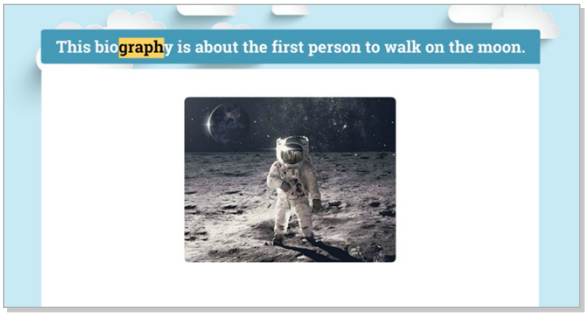


Figure 42. Students in the 3–5 band learn the meaning of common word roots.

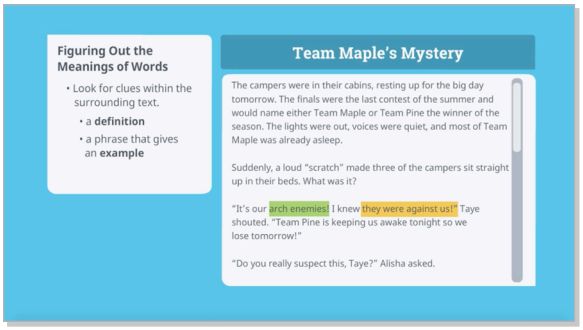


Figure 43. Students in the 3–5 band learn to use context clues to define challenging vocabulary.

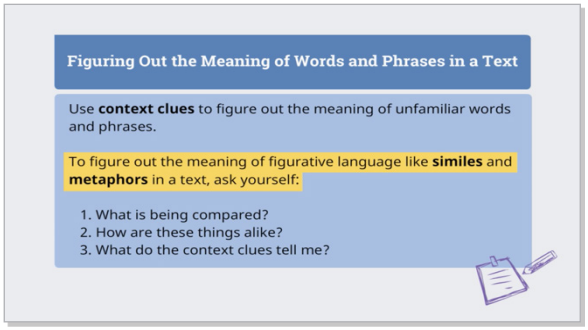


Figure 44. Students in the 3–5 band learn to use context clues to define similes and metaphors in a story.

Fluency

Fluency refers to the ability to read quickly, accurately, and with prosody. Fluent reading mimics spoken language, with proper inflection, phrasing, and pauses. Fluency is highly predictive of reading comprehension (NICHD, 2000; Torgesen & Hudson, 2006; Toste et al., 2017). Instruction should provide an intensive focus on foundational reading skills such as phonemic awareness, phonics, decoding multisyllabic words, and vocabulary to boost reading fluency (Torgesen et al., 2001; Toste et al., 2017). Teachers should model fluent oral reading across various texts and emphasize strategy use (e.g., context clues, checks for understanding) to boost students' reading fluency (Garnett, 2018; NICHD, 2000; Toste et al., 2017).

How MyPath K–5 Boosts Students' Reading Fluency

Across the curriculum, teachers and onscreen reading of text model expressive, fluent oral reading. Reading foundations build students' code-based and meaning-based skills to enhance fluent reading. Onscreen teachers model fluent reading (Figure 45). The teacher then applies these strategies to a story, first modeling a non-example with no prosody (e.g., skipping over punctuation, reading with no inflection) and mispronouncing words. She stops and reviews what it means to read accurately. This review includes a mini lesson on decoding and a mnemonic about punctuation: "I am a period. I look like a dot. Whenever you see me, you must stop." The teacher rereads the passage with fluency, highlighting important elements such as punctuation (Figure 46). The three *Early Literacy Bundles* emphasize determining a purpose for reading, rereading to correct errors, and reading aloud with expression. Offline printable materials also allow classroom teachers to conduct timed fluency assessments with students, as needed.

There are various comprehension checks while reading text, such as emphasizing words, sentences, and context clues. Highlighted onscreen text enhances word reading, allowing students to track intonation during oral reading. Students can elect to have the audio replay as necessary. When teaching how to read for understanding, onscreen teachers encourage repeated reading with speed, accuracy, and understanding. For example, students learn how to identify what they read and why (Figure 47). They practice monitoring comprehension by checking for new words and correctly reading words. Students then practice repeated reading and apply these strategies to answer comprehension questions (Figure 48). Metacognitive bubbles enhance students' repeated reading engagement by emphasizing key details.

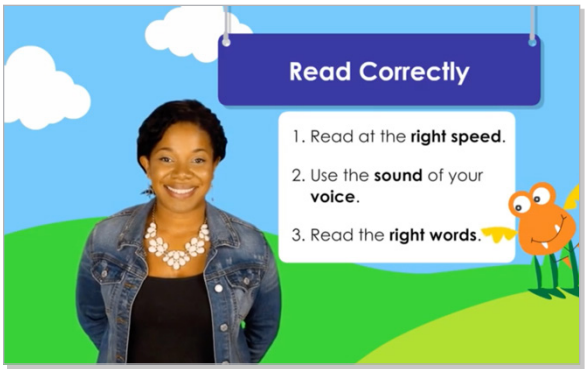


Figure 45. Students in the K–2 band learn how to fluently read text.

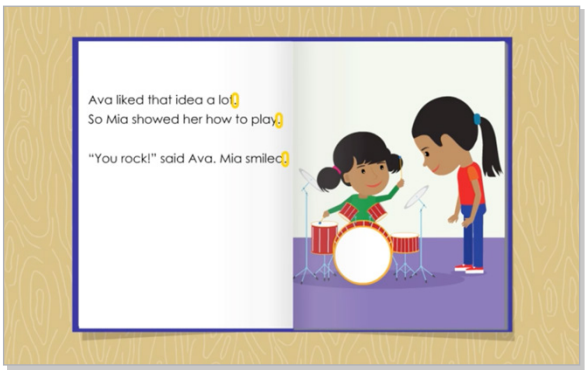


Figure 46. Students in the K–2 band hear fluent reading, with emphasis on intonation.

Figure 47. Students in the K–2 band hear a silly rhyme emphasizing the importance of fluent reading.

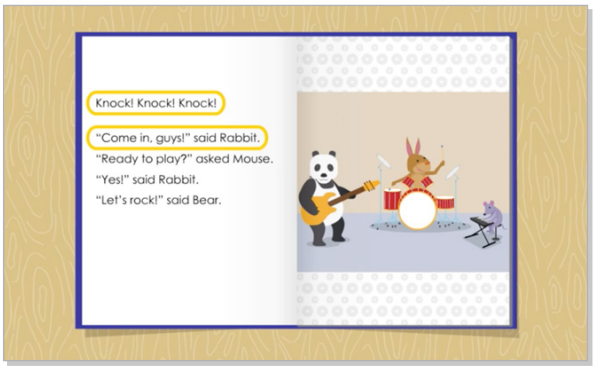


Figure 48. Students in the K–2 band learn to read fluently and monitor comprehension.

Reading Comprehension

Proficient readers flexibly apply a range of comprehension strategies (mental activities to deliberately remember what they read) to extract meaning from text. Research suggests instruction should explicitly teach strategies to improve comprehension, including activating background knowledge, identifying text structure, and applying a range of metacognitive strategies to monitor comprehension (Graves & Liang, 2008; NICHD, 2000; RAND Reading Study Group, 2002; Scarborough, 2001). Because background knowledge enables students to make rich connections across domains and experiences, an explicit focus on extending students' **background knowledge** should be a critical feature of literacy instruction (McLaughlin & DeVoogd, 2018). These rich connections increase the breadth and depth of information students bring to reading text, which improves students' ability to make inferences (using reasoning to conclude) and comprehend text (Torgesen & Hudson, 2006). The text should be commensurate with students' word-reading level to ensure students can access this breadth of information (Shanahan et al., 2010).

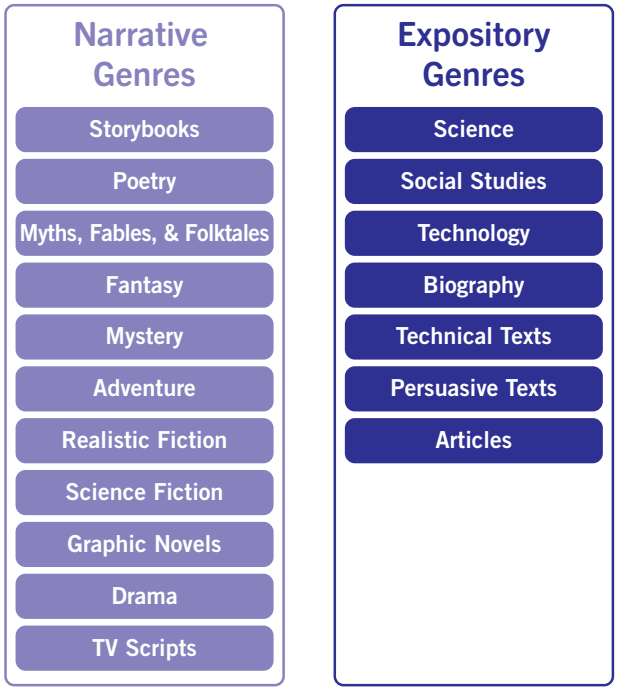
Explicitly teaching **metacognitive strategies** such as questioning, monitoring comprehension, visualizing, and summarizing boosts reading comprehension (NICHD, 2000). In a meta-analysis of 40 studies, Berkeley et al. (2010) concluded that teaching these metacognitive strategies is especially important for students with learning difficulties and disabilities, as struggling students tend to read haphazardly and do not actively monitor comprehension. Teaching these strategies should be direct but eventually fade,

to allow students to independently differentiate between text types and apply these metacognitive strategies in a more authentic setting (Graves & Liang, 2008).

Explicitly teaching **text structure** for both narrative texts (e.g., setting, character, plot, theme) and expository texts (description, chronology, causation, response, comparison) improves comprehension (Dymock, 2007; Hebert et al., 2016; Meyer, 1985; NICHD, 2000). These schemas (structured frameworks for extracting meaning) help students locate and identify pertinent elements in the story to enhance comprehension. Teaching these schemas is especially critical for expository text. Students tend to have greater difficulty comprehending expository text, likely because the text structure is less familiar than narrative text patterns (McLaughlin & DeVoogd, 2018). Results from a meta-analysis of 45 studies indicate that breadth of expository text types and the number of interactive opportunities to assess text structure positively boost the effects of explicit text-structure instruction (Hebert et al., 2016).

How MyPath K–5 Enhances Students' Reading Comprehension

MyPath K–5 emphasizes comprehension. Students must access code-based skills and accurately apply meaning-based skills to comprehend text. Lessons explicitly teach comprehension strategies across the curriculum in the context of connected text, which offers students an engaging and authentic means of extending their background knowledge. The curriculum provides rich exposure to a range of narrative and expository texts. Across grades, there is approximately a 50-50 emphasis on narrative and expository texts. Comprehension activities include textually and thematically complex text. Audio and visuals (including photos for expository text and illustrations for literature) support learning. The curriculum explicitly teaches prereading strategies, including previewing the text, activating background knowledge with a review of pertinent academic vocabulary, formulating questions about the passage, and setting a purpose for reading.



The curriculum incorporates a range of **metacognitive strategies** to support comprehension. For example, students learn and practice asking "Who?," "What?," "Where?," "When?," and "How?" to guide their reading and identify explicit and implicit key details within the story. There is an emphasis on using pictures and words to answer the "Who?" and "Why?" questions to identify explicit details and answer comprehension questions about the passages. Onscreen teachers model think-aloud strategies to make inferences during reading. Students learn that the author does not explicitly state every detail in a story. They practice identifying context clues (words and pictures) in the text and how to combine these clues with background knowledge (what I know) to make an inference (Figure 49). Teachers model asking questions such as, "Do you see any evidence?" to identify text evidence to support the inference. Metacognitive

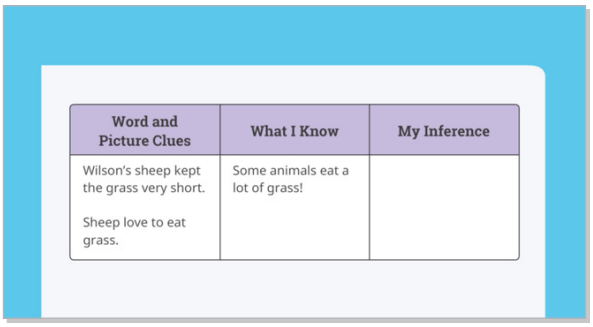
bubbles remind students to ask whether the text evidence in the story supports their inference. Students watch the onscreen teacher combine context clues with their background knowledge in a table as they read aloud to understand the text (Figure 50).

Onscreen teachers model identifying the topic by looking at the title and the first paragraph and asking, "What is the whole text about?" Students learn to identify the main idea by monitoring their comprehension paragraph by paragraph and using clues, pictures, and visualization to support these comprehension strategies. Teachers say, "Ask yourself, what is the most important idea in this paragraph?" Students practice identifying main ideas, and get immediate feedback. Teachers review these strategies with a range of texts and models (e.g., graphic organizers). For example, students read a passage about amazing aquatic ecosystems (Figure 51) and practice identifying and organizing key story elements in a chart (Figure 52). Onscreen highlighting emphasizes main ideas, key details, and relevant academic or domain-specific vocabulary. When the students answer incorrectly, they receive guidance on finding the correct answer (e.g., "This sentence gives the main idea of the paragraph. Read paragraph 3 again. Look for facts that support the main idea."). Other summarization activities include completing a graphic organizer relevant to the target skill, supporting an inference with text evidence, and completing a cause-effect diagram. These guided activities support independent comprehension.

Onscreen teachers model how to identify various text structures across narrative and expository text. For example, students learn about narrative story elements (e.g., characters, setting, plot) and how to use words and pictures as clues to organize the story elements (Figures 53 and 54). Students then practice with a range of narrative texts, focusing on how authors use metaphors, similes, personification, hyperbole, and symbolism to help the reader visualize story elements. Students continue to practice using context clues to figure out the meaning of figurative language. Because students often demonstrate difficulty with expository text structure, the curriculum offers extensive practice in understanding types of informational text structure, including description (Figures 55 and 56); chronology (Figures 57 and 58); causation (Figures 59 and 60); response (Figures 61 and 62); and comparison (Figures 63 and 64).

For each type, lessons begin with an overview identifying specific text features to differentiate between different types. Students practice identifying these features with engaging passages. For example, students learn that chronological text is usually organized with sequential steps marked with signal words (e.g., "then") to identify the next step. Students read an engaging "how to" guide about building homemade piñatas. Highlighting text visually reinforces specific text features. Students then apply their understanding of text features to answer comprehension questions. The curriculum includes lessons requiring students to differentiate between types to boost students' understanding of schemas across various expository texts.

Figure 49. Students in the 3–5 band learn how to use clues and background knowledge to make inferences.



Word and Picture Clues	What I Know	My Inference
Wilson's sheep kept the grass very short. Sheep love to eat grass.	Some animals eat a lot of grass!	

Figure 50. Students in the 3–5 band learn how to use text information to make inferences.

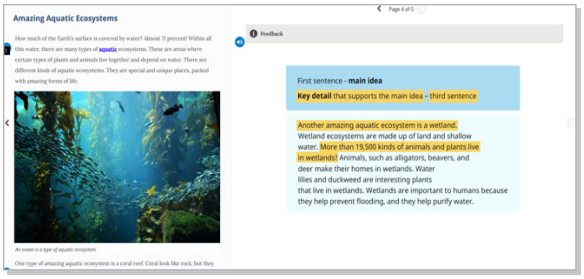


Figure 51. Students in the 3–5 band learn how to identify the main idea and key elements of an expository text.

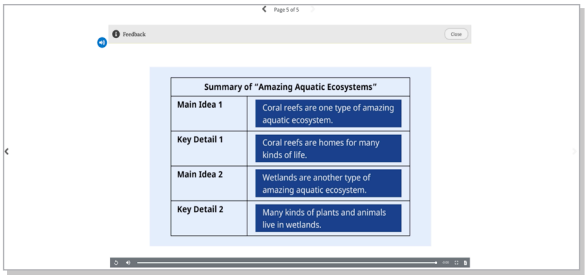


Figure 52. Students in the 3–5 band practice organizing the main idea and key elements in a chart.

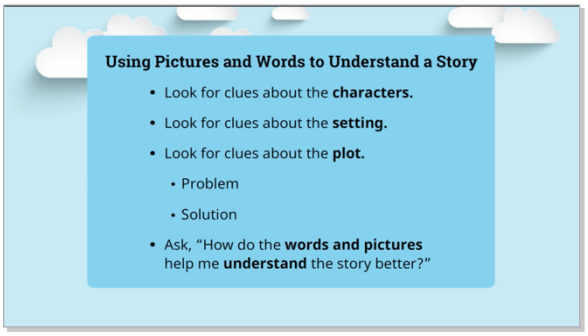


Figure 53. Students in the 3–5 band learn to use clues to identify characters, setting, and plot in a narrative.

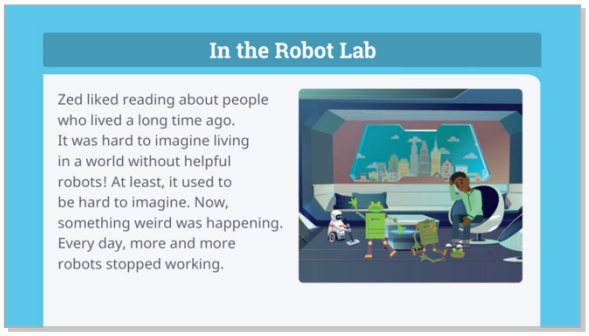


Figure 54. Students in the 3–5 band practice identifying narrative story elements.

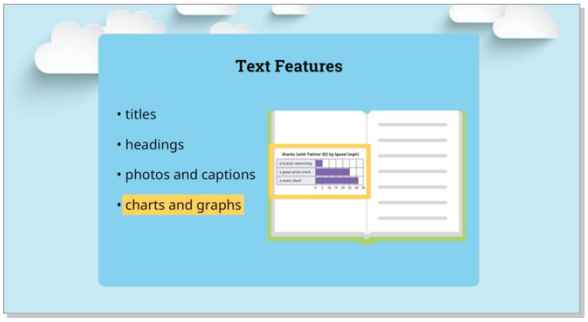


Figure 55. Students in the 3–5 band learn to use text features to understand a descriptive text.

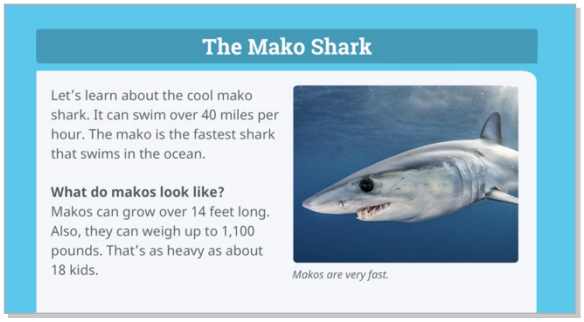


Figure 56. Students in the 3–5 band practice using descriptive text features to learn about sharks.

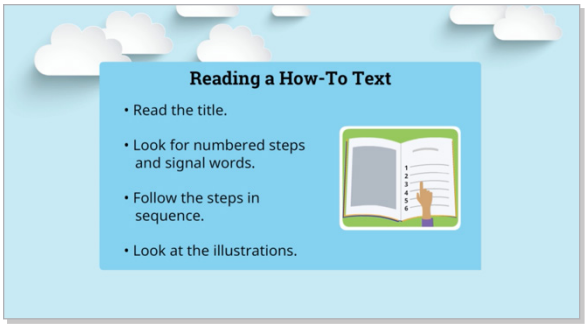


Figure 57. Students in the 3–5 band learn to use text features to understand a chronological text.

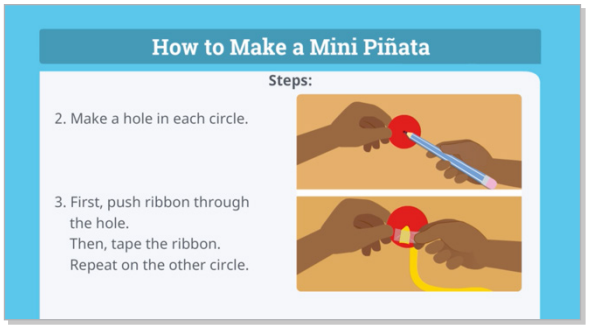


Figure 58. Students in the 3–5 band practice using chronological text features to learn about making piñatas.

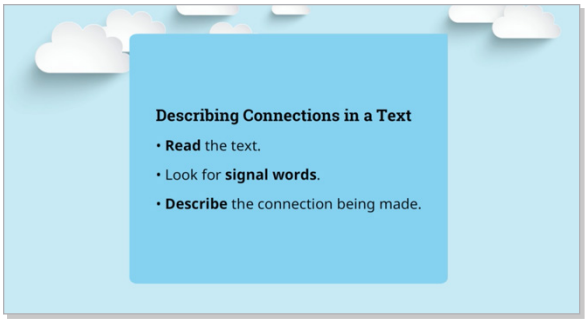


Figure 59. Students in the 3–5 band learn to use text features to understand a causal text.

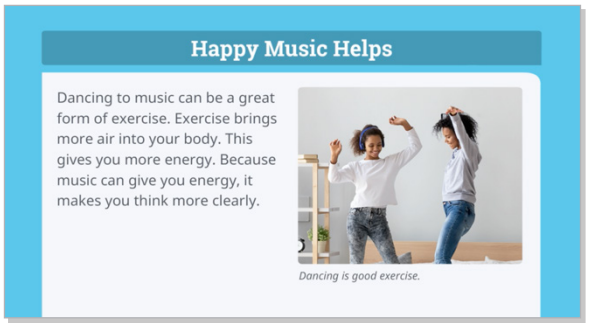


Figure 60. Students in the 3–5 band practice using causal text features to learn about stress and energy.

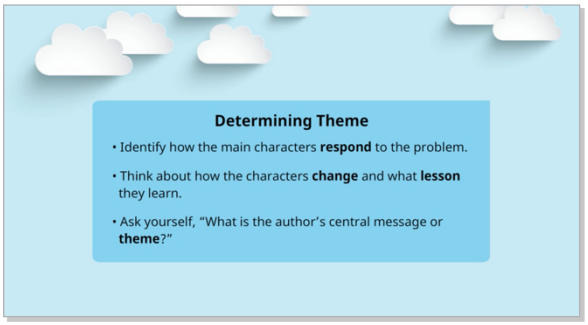


Figure 61. Students in the 3–5 band learn to use text features to identify the theme of a response.

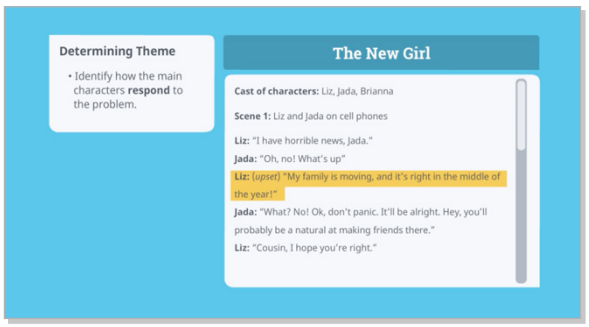


Figure 62. Students in the 3–5 band practice using response-text features to read a script.

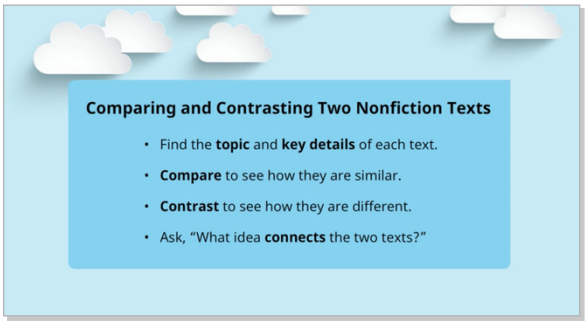


Figure 63. Students in the 3–5 band learn to use text features to compare and contrast.

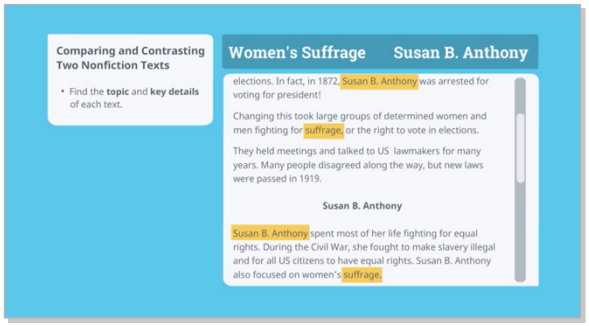


Figure 64. Students in the 3–5 band practice using text features to compare and contrast two passages.

Principle 4: Incorporate Evidence-Based Practices for Teaching Mathematics

Mathematics learning is additive and multidimensional. Understanding mathematics is a process of acquiring new knowledge, connecting this knowledge to new contexts, and quantitatively and abstractly reasoning through solutions in meaningful ways (National Governors Association Center for Best Practices, 2010; National Council for Teachers of Mathematics [NCTM], 2014). The National Research Council (2001, p. 6) defines mathematics proficiency as five overlapping strands, which intertwine like a rope to advance mathematics knowledge.

- **Conceptual understanding**: comprehend relationships across ideas, operations, and patterns.
- **Procedural fluency**: flexibly and accurately apply algorithms (a series of steps to solve a problem).
- **Strategic competence**: flexibly apply strategies to represent and solve problems.
- **Adaptive reasoning**: logically reason, explain, and justify problems.
- **Productive disposition**: recognize the advantages and utility of mathematics and required effort to achieve success.

However, many students struggle to master skills within each strand, which is detrimental to mathematics achievement. Approximately 17 percent of U.S. students persistently struggle in mathematics, often demonstrating difficulty with problem solving, assessing numerical magnitude, memorizing and retrieving basic arithmetic facts, and multistep applications (e.g., Geary, 2011; Shalev & Gross-Tsur, 2001). To combat these difficulties, research suggests mathematics instruction must be explicit and systematic (logically progressing from one skill to another) and must prioritize rigorous mathematics standards (Archer & Hughes, 2011; Fuchs & Fuchs, 2001; Fuchs et al., 2021; Fuchs et al., 2017; Gersten, Beckman, et al., 2009; NCTM, 2014). Students should hear expert teachers model correct verbal explanations of all concepts and procedures, receive ample support during guided practice, and practice with immediate feedback and cumulative review (Gersten, Chard, et al., 2009).

Research suggests instructional progressions should prioritize concepts and operations with whole and rational numbers, while also addressing spatial reasoning, algebraic thinking, and measurement (Gersten, Beckman, et al., 2009; Hudson & Miller, 2006; National Research Council [NRC], 2001; Student Achievement Partners, 2020). Instruction should balance developing students' conceptual understanding, declarative knowledge (i.e., memorization and automaticity), procedural knowledge, and problem-solving skills (i.e., applying concepts and procedural skills to real-world contexts) (Hudson & Miller, 2006).

Conceptual understanding and procedural fluency develop iteratively and recursively (National Mathematics Adivosry Panel [NMAP], 2008; Rittle-Johnson & Schneider, 2015). Procedures without conceptual understanding lead to confusion and misapplication of strategies across content areas (Rittle-Johnson et al., 2001). Students must ground their learning in an everyday context, and see various problem-solving approaches, visual models, and examples and non-examples to understand the conceptual underpinnings of concepts taught (NCTM, 2014; NMAP, 2008). Understanding the concepts underlying a range of mathematics topics provides a robust foundation for all applications, promoting students' ability to reason abstractly and quantitatively, persevere in the problem-solving process, model with mathematics, strategically use a variety of tools, attend to precision, make use of structure, look for patterns in reasoning, and recognize mathematics as practical and worthwhile (Fuchs et al., 2008; Hudson & Miller, 2006; National Governors Association of Best Practices, 2010; NCTM, 2014; NRC, 2001). Below, we outline how MyPath K–5 incorporates best practices for building conceptual understanding, procedural fluency, strategic competence, and adaptive reasoning.

Conceptual Understanding

Research supports incorporating the concrete-representational-abstract (CRA) framework to help students visualize concepts to promote conceptual understanding (Brunner & Kenney, 1965; Hudson & Miller, 2006). In the concrete phase, teachers use three-dimensional manipulatives (e.g., base 10 blocks, fraction circles) to create a mental model of the mathematics

concept. In a meta-analysis of 35 studies, Moyer-Packenham & Westenskow (2012) found that virtual representations of three--dimensional manipulatives were slightly more effective than physical representations. In the representational phase, teachers use two-dimensional pictures (e.g., number lines), diagrams, or drawings to demonstrate the same concept. In the abstract phase, students apply this conceptual knowledge to solve mathematics problems with numbers and symbols only. CRA has a longstanding history of improving conceptual understanding across domains, including whole numbers (Flores et al., 2014), rational numbers (Butler et al., 2003), and algebraic reasoning (Witzel et al., 2003).

Whole Numbers

Number sense, the general awareness that numbers hold value and can be manipulated and compared, is foundational for developing mathematics proficiency (Gersten & Chard, 1999; Hannula-Sormunen et al., 2015; Jordan & Dyson, 2016; Jordan et al., 2015; NMAP, 2008; NRC, 2009). Number sense includes the ability to flexibly reason about numbers (approximation and estimation), accurately assess numerical magnitude (comparison and equivalence), understand numerical writing conventions and place-value concepts, understand numerical language, and understand additive principles (Witzel et al., 2016). Integrating these concepts forms the conceptual basis of number sense, and predicts students' fluency with basic facts (Jordan et al., 2010), understanding of part-part and part-whole concepts that are critical for rational-number understanding (Clements, 1999), and later mathematics achievement (Nguyen et al., 2016). Poor number sense is associated with deficits in computation (Lokuniak & Jordan, 2008), poor fraction knowledge (Jordan et al., 2013; Vukovik et al., 2014), poor mathematics achievement (Jordan et al., 2009; Schneider et al., 2009), and mathematics learning disabilities (Geary et al., 2009).

Number sense progresses along a developmental trajectory (Frye et al., 2013). Research supports explicitly teaching the following concepts to improve students' number sense (Jordan & Dyson, 2016; Sarama & Clements, 2014):

- **Subitizing:** Promote students' fluency with recognizing amounts without counting (perceptual subitizing) to support conceptual subitizing (the ability to decompose numbers into part-whole sets) (Hutchison et al., 2020).
- **Counting:** Provide a strong focus on counting (one-to-one principles assigning a number to a set or group of objects), one-to-one correspondence (each counted number refers to an item in the set), and how counting relates to cardinality (the last number in the count is the value for the set) to promote number knowledge (Clements & Sarama, 2008; Fuchs et al., 2013; NRC, 2009).
- **Number-after knowledge:** Teach students how to count on from numbers other than 1 to support efficient counting principles (Fuchs et al., 2013).
- **Mentally compare numbers:** Emphasize magnitude understanding of adjacent numbers (e.g., 5 and 6) using a range of concrete models (NMAP, 2008; NRC, 2001; Siegler et al., 2011).
- **Symbolically compare numbers:** Emphasize that adjacent numbers are "one more" (e.g., 5 and 6) and are represented by printed numerals (Sarama & Clements, 2009).

Once students can symbolically compare smaller numbers, instruction should extend to develop students' whole-number magnitude knowledge and estimation ability with bigger whole numbers (Siegler, 2016). Understanding whole-number magnitude is highly predictive of future success with fractions and overall mathematics achievement (Bailey et al., 2014; Booth & Siegler, 2006; Namkung et al., 2018; Resnick et al., 2016; Wong, 2019). Research supports the following strategies for improving students' whole-number magnitude knowledge:

- Use linear modeling of whole numbers (e.g., number lines, linear shapes) to measure, compare amounts, and estimate (Namkung & Fuchs, 2019; Siegler & Ramani, 2009).
- Use a range of visual representations to emphasize unitizing (representing a quantity in different ways) and place-value concepts (Gersten, Beckman, et al., 2009; Lamon, 2012).

How MyPath K–5 Promotes Conceptual Understanding of Whole Numbers

Lessons prioritize conceptual understanding to build a strong foundation for developing procedural fluency, strategic competence, and adaptive reasoning to transfer learning to grade-level content. Onscreen teachers model high-quality explanations that are rich

with relevant mathematics vocabulary (e.g., defining the numerator and denominator in each fraction lesson), engage students in predicting answers based on background knowledge, and emphasize that there is more than one way to solve mathematics problems. For example, to prime students to learn about volume—the amount of space a solid, liquid, or gas takes up—the onscreen teacher tells a funny story about needing to fill a fishbowl with water for a pet piranha. The teacher walks students through predicting how much water (using 1-liter jugs) it will take to fill the fishbowl. Students compare their predictions to reality.

To scale students from one topic to the next, lessons review concepts students should already know, to activate background knowledge and provide rich connections across topics and domains. For example, before delving into how to name fractions from pictures, the onscreen teacher reviews relevant fraction vocabulary (e.g., "whole," "numerator," "denominator") before applying the knowledge to the lesson goals.

Students see a range of visual representations of concepts within the CRA model, multiple problem-solving strategies to approach complex problems, and repeated exposure to various problem types. For example, in a lesson teaching adding multidigit numbers, students first see a problem solved using concrete base 10 blocks (Figure 65) and then on a number line (Figure 66). Students then see the same progression as they solve a more challenging word problem with three-digit whole numbers (Figures 67 and 68).

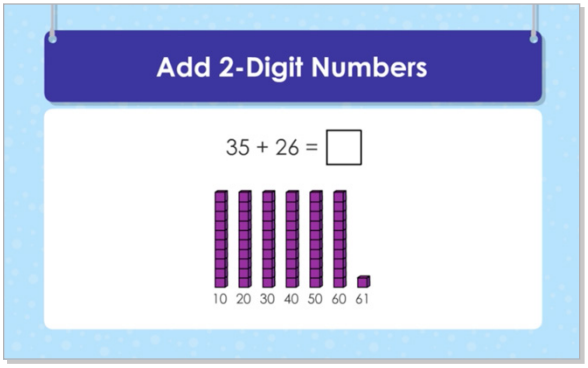


Figure 65. Students in the K–2 band use base 10 blocks to add two-digit numbers.

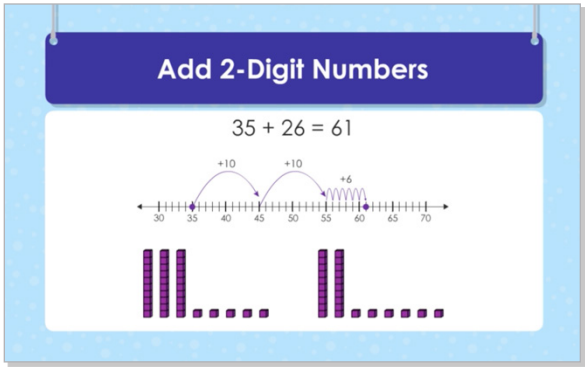


Figure 66. Students in the K–2 band use number lines and base 10 blocks to add two-digit numbers.

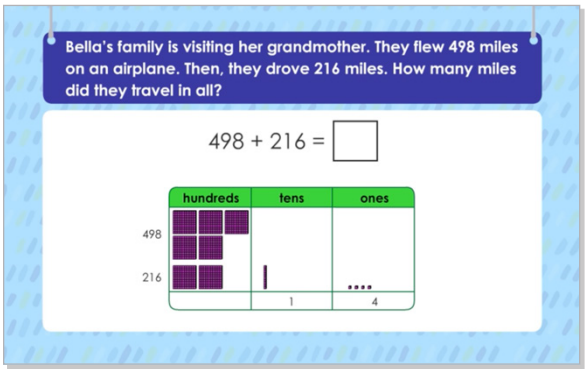


Figure 67. Students in the K–2 band use base 10 blocks to represent an addition word problem.

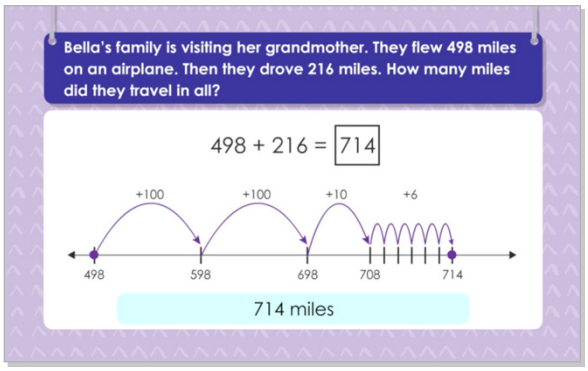


Figure 68. Students in the K–2 band use number lines to represent an addition word problem.

MyPath K–5 explicitly develops students' conceptual understanding across developmental progressions to improve students' number sense. Students practice perceptual subitizing with familiar objects (Figure 69). After listening to a word-problem story, students count sports objects (e.g., balls, whistles) to visually compare amounts. Students then practice conceptual subitizing by decomposing numbers into part-whole sets (e.g., three birds in a tree and three birds flying makes six birds altogether, Figure 70). Students count with everyday objects (e.g., shells). Onscreen teachers emphasize that each number counted goes with each object, and the last number spoken is the total in the set (Figure 71). Students practice counting on from numbers other than one

to support more advanced counting strategies (Figure 72). For example, students learn that it is more efficient to count on from the bigger number to find the total (e.g., to figure out what 3 + 2 =, students hold the bigger addend in their palm and count "4…5" to figure out the answer). Lessons emphasize comparing adjacent numbers mentally and with numbers. For example, the onscreen teacher says, "Each time I add one more to a number, I can rename the next number in the counting order." Students then see a range of examples with concrete models and numbers (Figure 73) and hear mathematics vocabulary (e.g., "there are fewer jump ropes than hoops," "6 is greater than 5") to emphasize magnitude understanding (Figure 74).

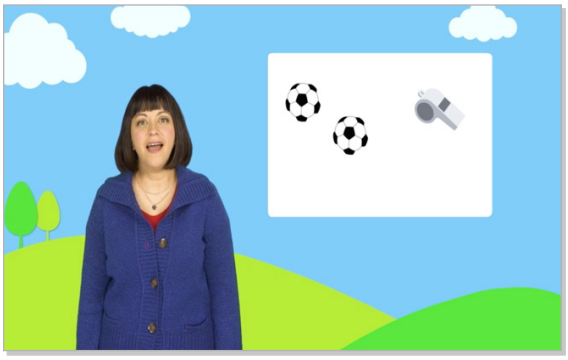


Figure 69. Students in the K–2 band practice quickly identifying the number of objects without counting.

Figure 70. Students in the K–2 band practice decomposing numbers into part-whole sets.

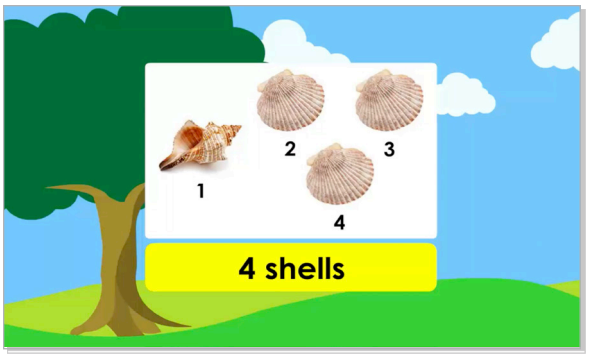


Figure 71. Students in the K–2 band practice counting common objects.

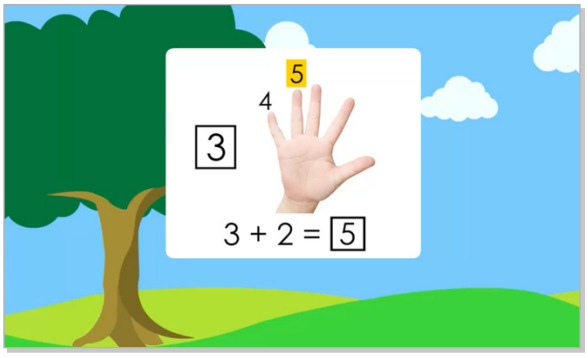


Figure 72. Students in the K–2 band learn counting-on strategies to build fluency with basic facts.

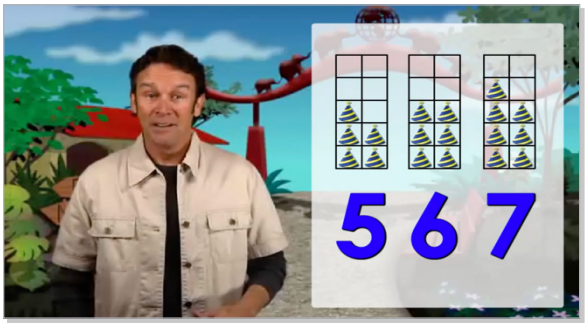


Figure 73. Students in the K–2 band learn number-after principles with visual support.

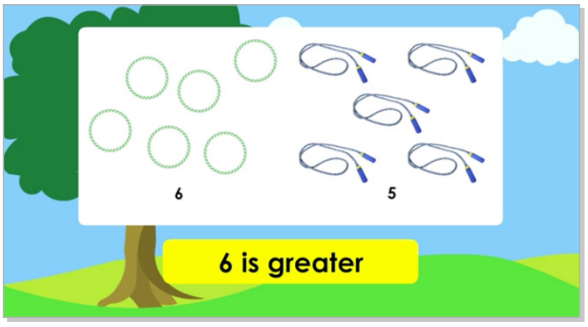


Figure 74. Students in the K–2 band practice comparing amounts by counting common objects.

The curriculum incorporates pictures, 10-frames, base 10 blocks, number lines, rulers, linear shapes, and video demonstrations to teach whole-number magnitude concepts. There is a strong emphasis on linear modeling and estimating value. For example, a video demonstration shows two people using ribbon as a linear model in a measurement lesson (Figure 75): "When we align the pieces of ribbon together, we can see that one is bigger than another. We want to know how much bigger it is. Let's estimate the length of each piece of ribbon, making sure we line up the end of each ribbon with the zero mark on the ruler." The video shows

them measuring the length of each piece of ribbon with a ruler (analogous to a number line), checking the actual value against their estimate, and comparing the lengths (5 inches < 10 inches). In another lesson, onscreen teachers use a sub sandwich as a linear model to teach students how to measure using nonstandard units (Figure 76). Students estimate the sandwich's length using toothpicks, and then check their estimate compared to the actual length. Using a linear model with nonstandard units emphasizes that numbers get bigger as the length increases (i.e., more toothpicks mean a longer sandwich).

To emphasize unitizing, lessons use pictures and 10-frames. Students learn how to bundle items such as crayons and animals in a pen into groups of 10s and 1s (Figure 77): "The number in the 10s place tells how many 10s. The number in the 1s place tells how many 1s." To extend students' unitizing skills to place value concepts, lessons use base 10 blocks to teach students how to compare whole numbers (Figure 78). To compare 45 and 48, the onscreen teacher first places four 10s rods in each of the place-value charts, and then adds five 1s for 45 and eight 1s for 48. He emphasizes that there is the same number of 10s rods, but five 1s are less than eight 1s. Students see a completed number sentence with the correct signs. The onscreen teacher emphasizes magnitude language (e.g., "less than," "equal to," "greater than") and shows that the number sentence can be correctly written in two ways.

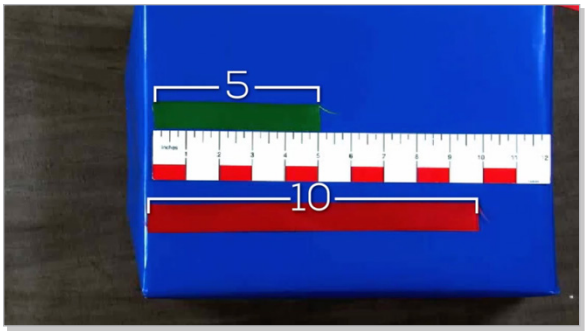


Figure 75. Students in the K–2 band use ribbon as a linear model to compare measurements.

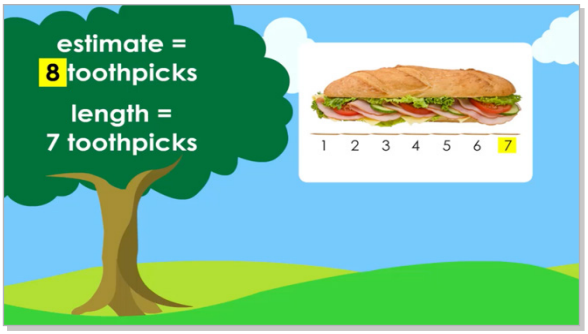


Figure 76. Students in the K–2 band use a sub sandwich to model measuring with nonstandard units.

Figure 77. Students in the K–2 band use crayons to learn multiplicative principles.

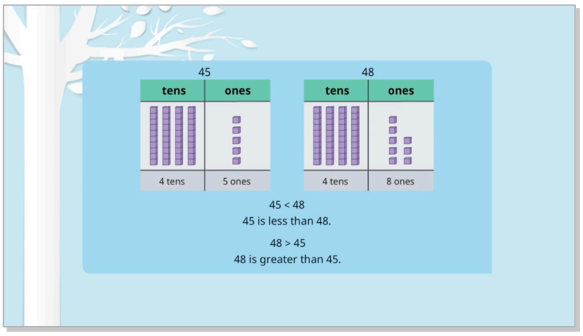


Figure 78. Students in the K–2 band use base 10 blocks to visually compare amounts.

Rational Numbers

In Grades 3–4, the curriculum shifts from an emphasis on whole numbers to one on rational numbers. Many students struggle with this shift and misapply the one-to-one counting principles of whole numbers to fractions, a phenomenon called whole-number bias (Ni & Zhou, 2005). Because magnitude is the common thread among all numbers, conceptual instruction should focus on helping students extend their mental number line to include fractions (Siegler et al., 2011). "The magnitudes of all rational numbers are represented on a mental number line, a dynamic structure that begins with small whole numbers and over the course of development expands rightward to include larger whole numbers, leftward to include negative numbers, and interstitially to include fractions and decimals" (Seigler, 2016, pp. 342–343).

Fluency with assessing fraction magnitude is positively related to future achievement, even controlling for proficiency with whole numbers and fraction computation (Siegler & Pyke, 2013; Torbeyns et al., 2015). Research supports the following strategies for improving students' fraction magnitude knowledge:

- Use **number lines** as the representational unit to extend students' conceptualization of number and prevent misapplication of whole-number principles to fractions (Fuchs et al., 2013; Fuchs et al., 2017; Gersten et al., 2017; NMAP, 2008; Siegler et al., 2010).
- Use a range of **visual representations** (e.g., sets vs. part-whole pictures vs. number lines vs. fraction notation) to model reasoning about fraction equivalence and comparisons (Lamon, 2012; NMAP, 2008; Siegler et al., 2010).
- Teach **flexibility of unit** to emphasize that comparisons are only valid when they refer to the same whole (Lamon, 2012).
- Teach **conceptual comparing strategies**, i.e., using the numerator and denominator's meaning to assess value with the same numerator and same denominator comparisons (Fuchs et al., 2013; Malone & Fuchs, 2017; Wang et al., 2019).
- Use knowledge of whole-number **place value**, knowledge of fractions, and accurate place-value labels (e.g., read 0.34 as "34 hundredths" rather than "point 34") to write and compare decimals as fractions to boost students' decimal magnitude knowledge and relationship to common fractions (Malone et al., 2017; Malone et al., 2019).

How MyPath K–5 Promotes Conceptual Understanding of Rational Numbers

The curriculum incorporates various models (e.g., part-whole diagrams, number lines) of rational numbers to help students develop a mental number line to extend their concept of number and apply this knowledge in real-world contexts. Lessons emphasize pertinent vocabulary (e.g., numerator, denominator, equivalent) with frequent review of definitions, highlighting, and multimedia representations.

For example, to teach students how to represent and compare fractions on a number line, a lesson uses a word-problem story about running a mile to contextualize the concept's utility. The onscreen teacher uses a part-whole diagram to represent a mile, and says the mile is divided into eight equal parts and five of those eight equal parts shows five-eighths of a mile (Figure 79). Then he likens this visual model to the number line to show the same amount (Figure 80). He then models how to use the number line to compare two fractions with the same denominator. This teaching sequence is also applied to teaching fraction equivalency. Students use a word-problem story to model how $^1/_4 = ^2/_8$ using a part-whole diagram (Figure 81) and the number line (Figure 82). The onscreen teacher emphasizes that an equivalency assessment is only valid when both fractions refer to the same unit.

Lessons incorporate conceptual comparing strategies for comparing fractions with the same numerator and the same denominator. Before a fraction comparison lesson, the onscreen teacher reviews comparing whole numbers, to prime students to pay attention to differences when comparing fractions. That is, students must consider the meaning of the numerator and the denominator to determine value. The onscreen teacher uses part-whole diagrams to highlight that when two fractions have the same numerator, they must look to the denominator to decide which is bigger (Figure 83). The fraction with the bigger denominator is divided into smaller parts; the same number of parts equals a lesser amount. For the same denominator comparisons, the units are divided into the same-size parts, so the fraction with more parts (the bigger numerator) is the greater amount (Figure 84). Lessons also emphasize how to determine whether a fraction is less than 1, equal to 1, or greater than 1, and how fractions can be written in equivalent forms (e.g., $1^3/_4 = ^7/_4$).

To emphasize the connection between fractions and decimals, lessons focus on teaching students how to identify and write decimal fractions (a fraction with a denominator of 10, 100, 1,000, etc.). Lessons use money as a model to contextualize learning. For example, students use a place-value chart to practice writing a decimal as an equivalent fraction (Figure 85). They learn that the place-value position furthest to the right (e.g., hundredths) indicates the denominator. Then they learn how to write an equivalent decimal with hundredths (Figure 86).

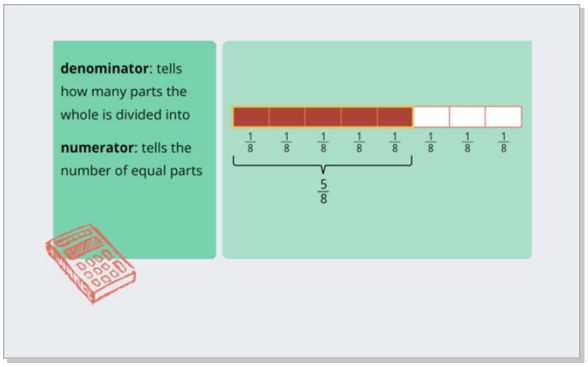


Figure 79. Students in the 3–5 band learn to use part-whole models to represent fractions.

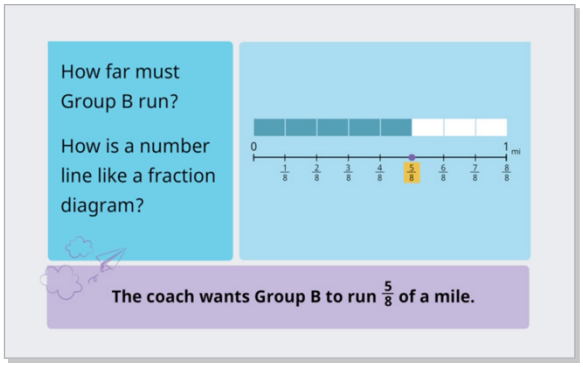


Figure 80. Students in the 3–5 band learn how part-whole models are like fraction number lines.

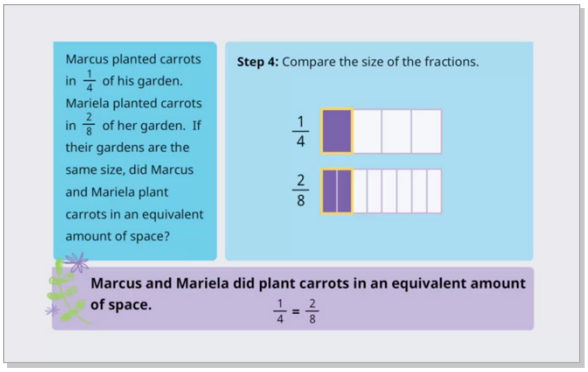


Figure 81. Students in the 3–5 band learn fraction equivalency with part-whole models.

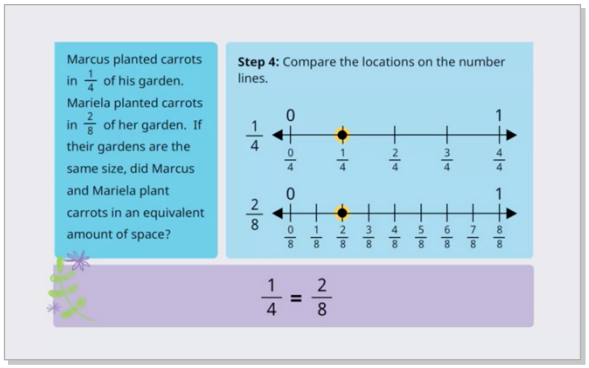


Figure 82. Students in the 3–5 band learn fraction equivalency with number lines.

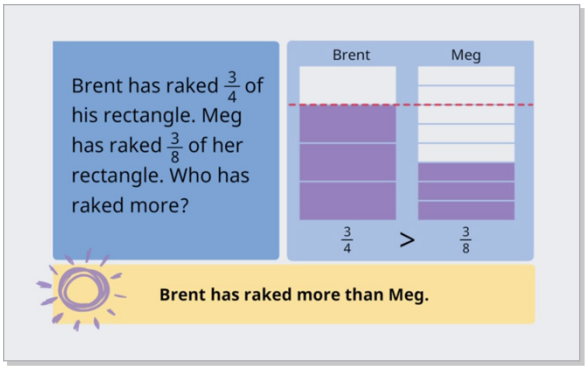


Figure 83. Students in the 3–5 band learn to compare fractions with part-whole models.

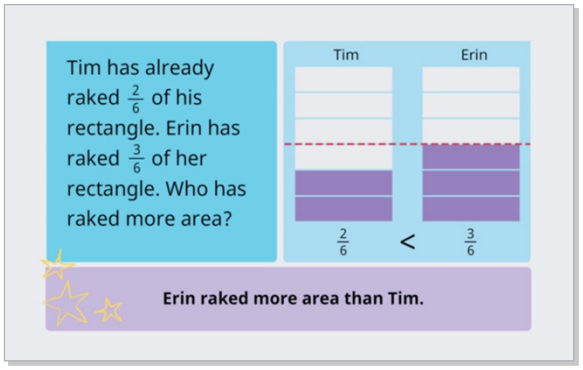


Figure 84. Students in the 3–5 band learn to compare fractions with part-whole models.

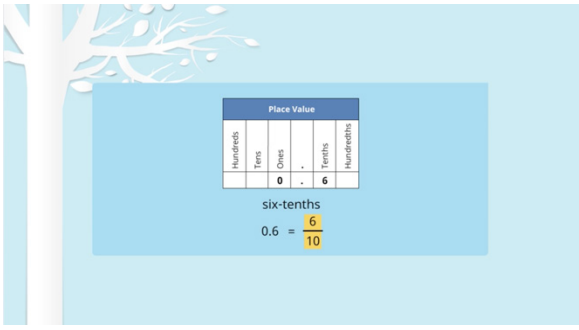


Figure 85. Students in the 3–5 band learn fraction-decimal equivalency using place-value charts.

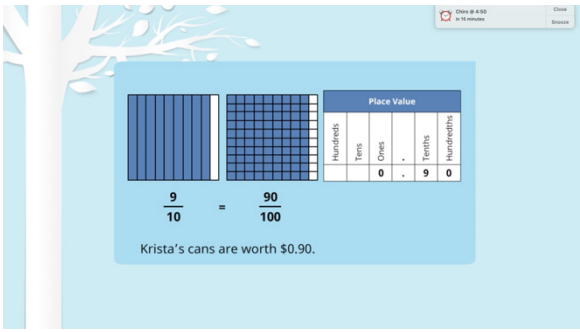


Figure 86. Students in the K–2 band learn fraction-decimal equivalency with visual supports.

Spatial Reasoning

Spatial reasoning refers to the ability to identify, visualize, and rotate two- and three-dimensional objects and images. Students' spatial reasoning predicts mathematics proficiency across various skills, including arithmetic, geometry, measurement, and word-problem solving (Reinhold et al., 2020; Zhang et al., 2014). Research suggests struggling students have significant difficulty with spatial reasoning (Swanson & Jerman, 2006). To improve students' visual-spatial skill across domains, instruction should (Battista & Clements, 1996; Dobbins et al., 2014; NRC, 2001; Resnick et al., 2020; Seah & Horne, 2020):

- Use clear language to describe properties of two- and three-dimensional objects and shapes using a range of models (e.g., common objects, graphs, charts, diagrams).
- Provide explicit connections and practice with measurement concepts.

How MyPath K–5 Develops Students' Spatial Reasoning

Onscreen teachers use precise language to describe similarities and differences between two- and three-dimensional shapes and how these features relate to common objects. For example, students learn that cylinders, spheres, and cones can roll and have no edges or corners, whereas cubes, pyramids, and rectangular prisms cannot roll and have only flat parts (Figure 87). Onscreen highlighting emphasizes these features as the teacher speaks. Then the teacher models how to use these attributes to devise ways to sort them (e.g., shapes with solid faces vs. curved faces) and how to recognize these features in real objects (e.g., students' desks have edges where two faces meet). Students also learn to analyze and compare two-dimensional shapes using informal and mathematics language (e.g., "big," "small") to describe their similarities, differences, and other attributes (e.g., color, edges, dimensionality) and how to identify smaller shapes within larger shapes.

Lessons incorporate a range of models (e.g., pictures, three-dimensional objects, geoboards, rulers, charts, graphs, diagrams) to provide connections to real-world contexts and problem solving. For example, students practice making bar charts with three-dimensional objects (Figure 88). The onscreen teacher presents a problem about students choosing different snacks (carrots or granola bars). The teacher organizes the students' choices on a bar graph to show that more students chose granola bars. Assessing value on a chart (two-dimensional) with three-dimensional objects connects students' spatial reasoning, counting, data analysis, and word problem-solving skills.

Lessons explicitly connect spatial-reasoning skills to measurement. For example, students learn how to use geometric shapes to estimate an object's size (Figure 89). The onscreen teacher models measuring the length of a ribbon (represented as a horizontal line) using squares (all the same size). He emphasizes that an appropriate measurement cannot have any gaps or overlap. After lining up 18 squares to match the ribbon's length, the onscreen teacher counts them from left to right. This explicit connection emphasizes students' whole-number magnitude knowledge, represented on a number line. Students connect this knowledge to estimating and measuring objects using standard measurements and estimating the volume of a rectangular prism by counting unit cubes (Figure 90).

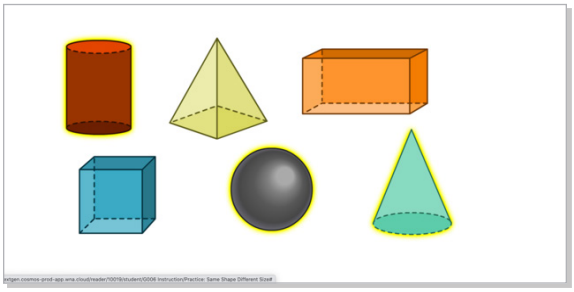


Figure 87. Students in the K–2 band learn to describe 3D objects.

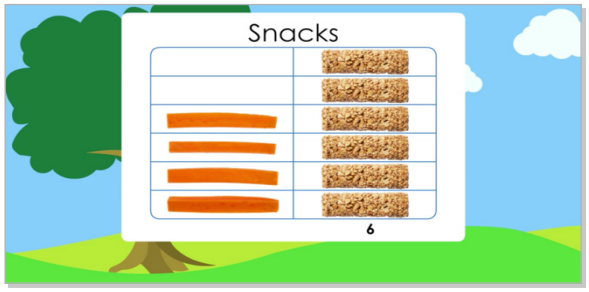


Figure 88. Students in the K–2 band learn compare amounts using common objects.

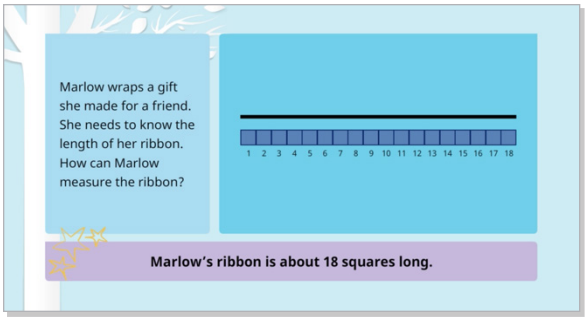


Figure 89. Students in the K–2 band (Grade 3–5 presentation) use shapes to estimate size.

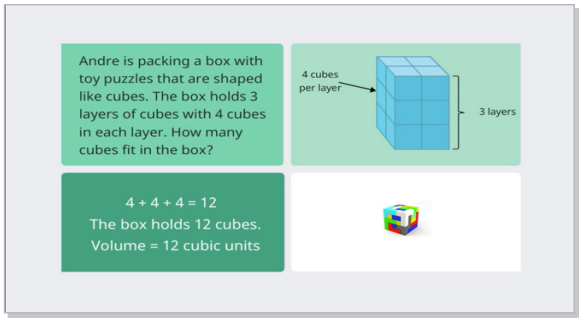


Figure 90. Students in the 3–5 band learn to estimate volume using unit cubes.

Procedural Fluency

Improving students' conceptual understanding of whole numbers, rational numbers, and spatial concepts influences their procedural fluency because they can better judge whether their answers make sense (Rittle-Johnson et al., 2001; Rittle-Johnson & Schneider, 2015). For example, when adding two multidigit (positive) whole numbers, the answer should be bigger than each of the addends. Students' whole-number magnitude knowledge and proficiency with place-value concepts enable them to assess the answer's value and determine whether they made a mistake.

Whole Numbers

Students' proficiency with **whole-number operations** (addition, subtraction, multiplication, and division) is critical, considering basic fact fluency and proficiency with multidigit addition and subtraction are essential for future success in more advanced mathematics (NCTM, 2000; NMAP, 2008). Yet, many students demonstrate pervasive difficulty (Gersten et al., 2005; Kroesbergen & Van Luit, 2003). Research suggests the following strategies for improving students' proficiency with whole-number operations:

- Scale students' conceptual understanding of place value with the CRA framework to model operations with concrete (e.g., base 10 blocks) and pictorial representations (e.g., number lines) to prepare them to picture the mathematics skill as they perform the procedural operation (Flores et al., 2014; Hudson & Miller, 2006; Siegler et al., 2010). These visual models emphasize procedural rules such as regrouping (addition and subtraction), grouping (multiplication), and remainders (division). These supports should be faded as soon as developmentally appropriate (Archer & Hughes, 2011).
- Emphasize strategy instruction for basic facts (e.g., counting on, counting up, +1 rule) and multiplication facts (e.g., zero rule, one rule, skip counting, order rule) with visual models (Hudson & Miller, 2006).
- Teach whole numbers as composite units to support students' shift from additive to multiplicative reasoning (Lamon, 2012; Tzur et al., 2018). To understand whole numbers as composite units, students require practice composing and decomposing numbers to support the development of multiplicative thinking, which is a precursor to proportional reasoning (Lamon, 2012; Tzur et al., 2018; Urlich, 2016).
- Emphasize relational understanding of the equal sign, and provide explicit instruction on nonstandard equations to improve students' accuracy and reasoning ability (Powell, 2012; Powell et al., 2015).
- Provide repeated exposure and ample practice applying strategies (Archer & Hughes, 2011).

Rational Numbers

Students' proficiency with **fraction operations** (addition, subtraction, multiplication, and division) is a stronger predictor of later mathematics achievement than proficiency with whole-number operations (Bailey et al., 2012). To boost proficiency, instruction should explicitly emphasize how fraction operations differ from whole-number operations, emphasizing why the procedures make sense (Fuchs et al., 2008; Fuchs et al., 2013; Lamon, 2012; Siegler et al., 2010). For example, instruction should emphasize the need for the same denominators for addition and subtraction and interpreting fraction multiplication as scaling (Fazio & Siegler,

2011). Students should be able to explain why the product increases when you multiply a factor by a fraction greater than one and decreases when you multiply a factor by a fraction less than one.

How MyPath K–5 Promotes Procedural Fluency

The curriculum extends students' conceptual understanding of number to build fluency with operations, using the CRA framework to teach addition, subtraction, multiplication, and division. Instruction introduces concepts with concrete manipulatives (e.g., base 10 blocks) to solve a range of problem types, before transitioning to representative models (e.g., diagrams, pictures, and number lines) and symbols and expressions.

Students extend their whole-number magnitude knowledge to practice adding multidigit numbers with base 10 blocks and a number line (Figure 70, above). They start with the first addend and then use place-value knowledge to skip count by 10s and then count up by 1s to derive the answer. The onscreen teacher discusses why the answer is larger than the starting amount. This visual model scales students to proficiency with regrouping and judging the reasonableness of their answers. There is extensive practice with challenging problem types, including adding and subtracting with regrouping, multiplying multidigit numbers by multidigit numbers, and dividing with remainders.

Onscreen teachers use a range of visual models to teach procedural strategies, including counting on to add, counting back to subtract, subtracting by 10, counting on by 1, adding and subtracting within 100, grouping numbers in various ways to add (Figure 91), skip counting by 2s, 5s, 10s, 25s, 50s, and 100s, and how repeated addition and multiplication relate. Strategies also focus on teaching students how to use mental mathematics (e.g., add and subtract within 20 and add and subtract by 10 or 100 using place-value knowledge).

Students have opportunities to apply these strategies across a range of topics. For example, in a geometry lesson, students learn that adding all the sides together (repeated addition) of a pentagon is the same as multiplying one side's length by the number of sides (Figure 92). This emphasizes whole numbers as composite units. Lessons also incorporate arrays to teach a range of grouping options and associated number sentences. For example, students see the various ways they can group eight oranges (e.g., two groups of four, four groups of two). They see how the array changes with different groupings and that the order of multiplication does not matter (Figure 93). They practice skip counting (i.e., counting forward by a number other than 1, such as 5, 10, 15, 20) to assess value, emphasizing multiplicative thinking.

Onscreen teachers focus on the relational definition of the equal sign, and students have extensive exposure to nonstandard equations across the curriculum. Students assess whether equations are true or false, and see a range of models to solve for the unknown in different positions (Figure 94). The unknown is represented by a symbol or a blank box to increase transfer to algebra.

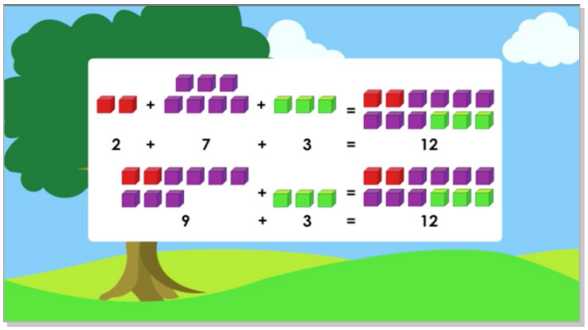


Figure 91. Students in the K–2 band practice decomposing numbers using cubes.

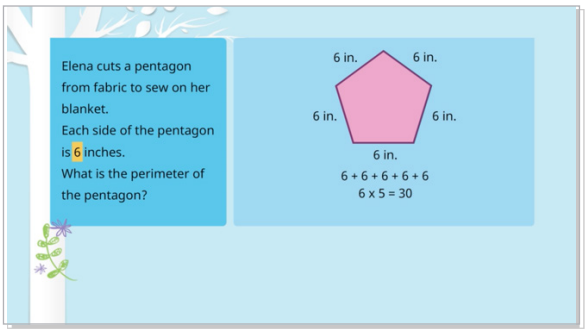


Figure 92. Students in the 3–5 band learn multiplication is the same as repeated addition.

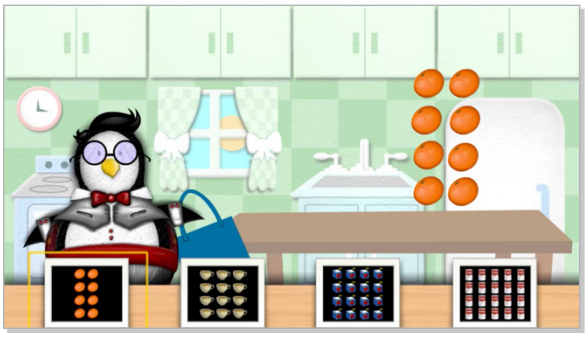


Figure 93. Students in the 3–5 band use arrays to model multiplication.

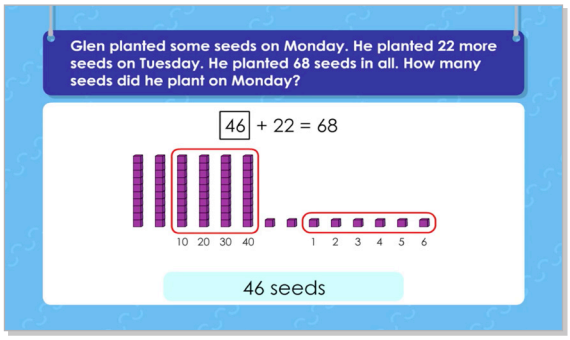


Figure 94. Students in the K–2 band learn to solve nonstandard equations.

Lessons emphasize why adding and subtracting fractions with unlike denominators differs from whole-number addition and subtraction. For fractions, the size of the parts must be the same before completing the operation. The onscreen teacher introduces this idea with a word problem and a visual model (Figure 95). Then he emphasizes why it is imperative to rewrite one or both of the fractions in an addition or subtraction equation so that they have the same denominator. The teacher shows how $^4/_8$ is the same amount as $^1/_2$ to solve the word problem (Figure 96).

Students use area models to represent the product of two fractions, as preparation to learning multiplication as scaling. For example, students learn that when you multiply a number by a fraction greater than 1, the product is greater than the factor. The onscreen teacher introduces an area word problem to contextualize the topic and connect the concept to geometry. She asks students to predict whether the answer will be greater than or less than the whole number factor. She then uses a part-whole diagram to demonstrate the procedure (Figure 97), and then emphasizes fraction equivalency using the same model (Figure 98).

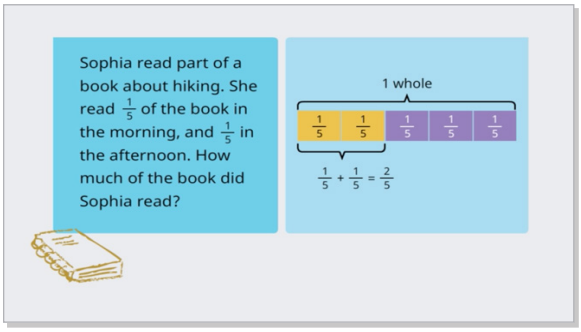


Figure 95. Students in the 3–5 band learn to add fractions with part-whole diagrams.

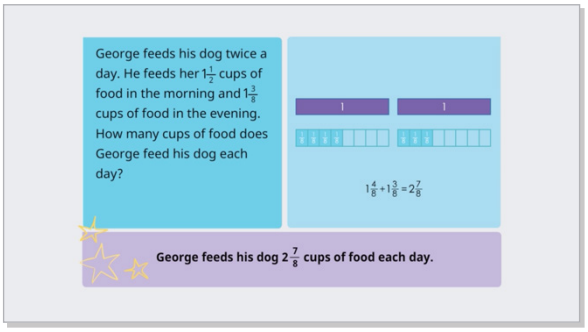


Figure 96. Students in the 3–5 band learn to add fractions with part-whole diagrams.

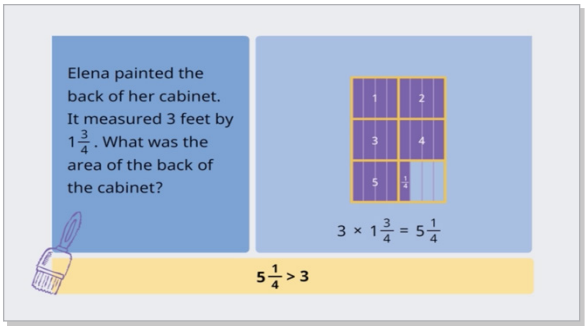


Figure 97. Students in the 3–5 band learn to multiply fractions with part-whole diagrams.

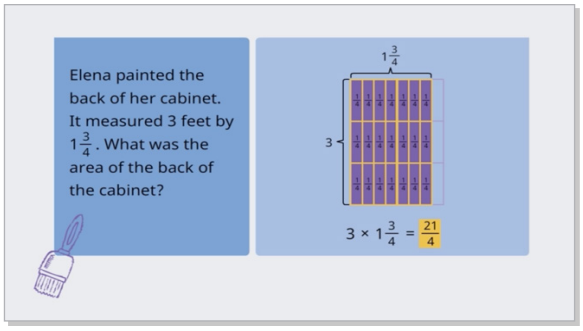


Figure 98. Students in the 3–5 band learn how to rewrite equivalent fractions using part-whole diagrams.

Strategic Competence, Adaptive Reasoning, and Productive Disposition

Strategic competence and adaptive reasoning "reflect the need for students to develop mathematical ways of thinking as a basis for solving mathematics problems that they may encounter in real life, as well as within mathematics and other disciplines" (NCTM, 2014, p. 7). To flexibly apply strategies and logically reason through solutions requires algebraic reasoning and proficient problem-solving skill. Both require the ability to attend to a range of concepts, models, and solution strategies to connect knowledge and arithmetic fluency to an efficient problem-solving approach (Woodward et al., 2012). Productive disposition develops through interacting with these various solution strategies. Through practice, students eventually develop an appreciation for the utility of mathematics (NRC, 2001).

Research suggests the ability to logically reason and verbally explain problems strengthens mathematics performance across a range of applications, including word-problem solving (Fuchs et al., 2016; Gersten, Beckman, et al., 2009; Rittle-Johnson, 2006). Proficient verbalization of thought processes enhances problem-solving skills with a recursive pattern of connecting background knowledge with new concepts, expanding students' mathematics knowledge base (Wittrock, 1989). This elaboration increases students' flexibility in persevering through challenging multistep problems.

To enhance students' algebraic reasoning and problem-solving skill, instruction must systematically minimize the learning challenge by offering logically sequenced lessons, clear explanations of strategy use, a solid conceptual foundation for all procedures, and explicit and systematic instruction on how and when to apply specific strategies (Fuchs et al., 2008; Fuchs et al., 2016; Fuchs et al., 2017; Fuchs et al., 2010; Kilpatrick et al., 2001). These instructional features support students' productive struggle in learning mathematics by embracing "a view of students' struggles as opportunities for delving more deeply into understanding the mathematical structure of problems and relationships among mathematical ideas, instead of simply seeking correct answers" (NCTM, 2014, p. 48).

Algebraic Reasoning

Algebraic reasoning refers to the ability to flexibly use symbols and rules governing those symbols to understand mathematical relationships and applications. Proficiency is highly correlated to future mathematics achievement and success after school (International Association for the Evaluation of Educational Achievement, 2019; NMAP, 2008). Yet, many students persistently struggle with algebraic reasoning (NAEP, 2019a). Four research-aligned principles boost proficiency among elementary students:

- Use a **range of models** (e.g., objects, graphs, diagrams) **and examples** to depict quantitative relationships and provide opportunities for students to analyze patterns, relations, and functions across contexts, to prevent students misinterpreting algebraic symbols (Hudson et al., 2006; MacGregor & Stacey, 1997; NCTM, 2000; Witzel et al., 2003). Recognizing patterns of quantitative relationships positively influences students' ability to understand relations among operations (e.g., communitive, associate, distributive, inverse operations).
- Provide a **robust rational-number curriculum** focused on developing students' magnitude knowledge and proficiency with fraction operations. Proficiency with rational-number concepts significantly predicts later algebra achievement (DeWolf et al., 2015; Siegler et al., 2012).
- Teach the **relational meaning of the equal sign**. Many students misinterpret the equal sign as a symbol of action, rather than a relational symbol indicating that both sides of the equation have the same value (Powell et al., 2020). This incorrect view inhibits students' ability to flexibly apply strategies and procedures to solve problems. However, explicitly teaching the relational meaning of the equal sign mitigates these difficulties and improves performance on both equation-solving and word-problem solving (Powell & Fuchs, 2010)
- Emphasize how **words and sentences translate into algebraic symbols** and equations (Groth, 2013).

How MyPath K–5 Develops Students' Algebraic Reasoning

Lessons across the domains explicitly support students' algebraic reasoning with a problem-solving approach and a strong focus on developing a conceptual understanding of procedures with whole and rational numbers, using a range of visual models. Lessons orient students using real-world problems and examples as an anchor, before teaching the content knowledge required to solve such problems. The curriculum supports students' productive struggle in mathematics with logically sequenced and scaffolded lessons designed to minimize the learning challenge and anticipate common misconceptions. Teachers introduce a range of strategies for solving problems and provide explicit guidance on how and when to use these strategies, allowing students to develop deep connections across concepts.

For example, lessons emphasize fact families (i.e., a collection of addition/subtraction or multiplication/division facts using the same numbers) to support students' understanding of the relationships among operations and how to use fact families strategically to solve for unknown numbers in equations. For example, students learn how to solve a word problem using fact families (e.g., the related facts 9 – 5 = 4; 9 – 4 = 5; 5 + 4 = 9; 4 + 5 = 9) and cubes to represent the problem (Figure 99). To anticipate students' misinterpretation of the equal sign, number-sense lessons strategically present number sentences from left to right (e.g., a + b = c) and right to left (c = b + a), and read the equal sign as "the same as" to minimize students' tendency to view the equal sign as an action when they solve equations (Figure 100). Students practice basic algebraic manipulations with equations (Figure 101) and word problems (Figure 102), using a range of models (e.g., cubes and number lines) to support understanding. Word-problem instruction emphasizes how to translate words into number sentences. Problems interleave practice, with missing numbers in different positions and various ways to demarcate a missing number, such as blanks, letters, and question marks.

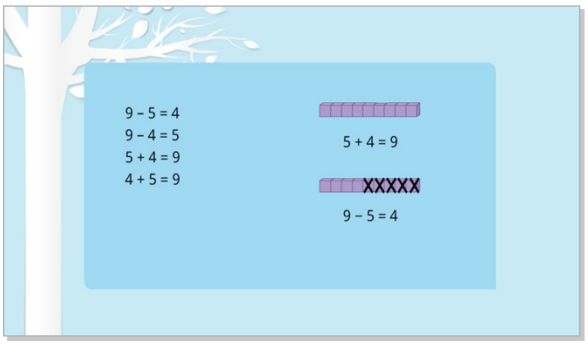


Figure 99. Students in the K–2 band learn fact families using visual supports.

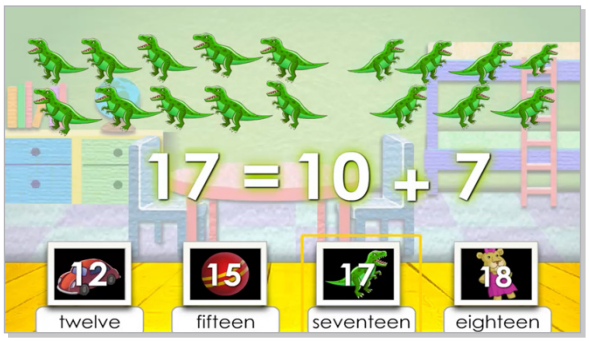


Figure 100. Students in the K–2 band learn the relational meaning of the equal sign.

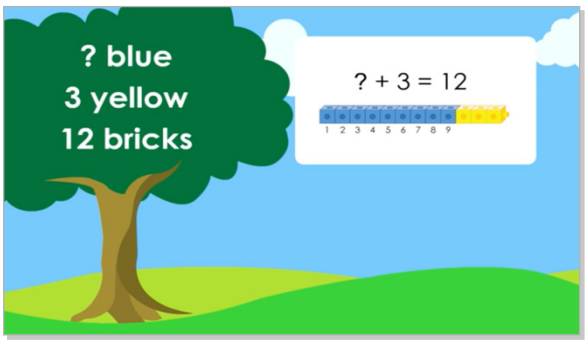


Figure 101. Students in the K–2 band learn basic algebraic manipulations with equations.

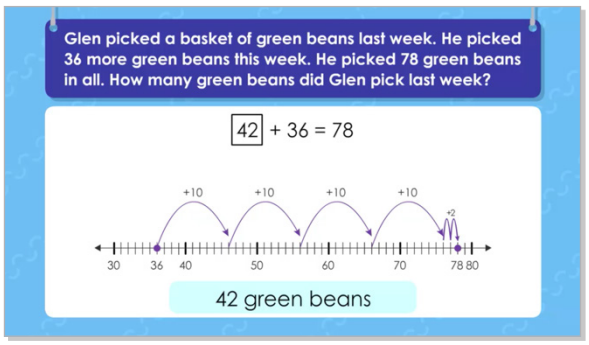


Figure 102. Students in the K–2 band learn basic algebraic manipulations with equations.

Problem Solving

To solve problems in real-world contexts, students must combine their conceptual knowledge, procedural skill, and problem-solving ability to successfully devise a strategy to solve complex problems (Hudson & Miller, 2006). **Problem solving** refers to using mathematics to analyze, represent, and flexibly model real-life problems using mathematics (NRC, 2001). There are four basic steps for solving a problem (Pólya, 1945): 1) understand the problem; 2) choose a strategy to solve the problem; 3) use the strategy to solve the problem; and 4) look back and check work.

> Effective problem-solvers constantly monitor and adjust what they are doing. They make sure they understand the problem.[…]They periodically take stock of their progress to see whether they seem to be on the right track. If they decide they are not making progress, they stop to consider alternatives and do not hesitate to take a completely different approach (NCTM, 2000, p. 54).

Research suggests explicitly emphasizing word-problem solving to model real-life applications (NCTM, 2000; NCTM, 2014; NMAP, 2008). Instruction should include modeling of proficient problem solving and ample opportunities to see a range of visual models (Gersten, Beckman, et al., 2009; Gersten, Chard, et al., 2009). This is especially vital for learners who significantly struggle with word problem-solving skills, such as verbal problem solving, verbal working memory, visual-spatial skill, metacognitive strategy use, and long-term memory (Shin & Bryant, 2015; Swanson & Jerman, 2006). These deficits negatively affect students' ability to successfully implement the four basic problem-solving steps, especially since these general heuristics are vague and do not provide explicit problem-solving guidance (Jitendra & Star, 2011).

According to a meta-analysis of 14 studies (Xin & Jitendra, 1999), effective word-problem interventions for students with, or at risk for, mathematics difficulties incorporated representation techniques (e.g., schema-based instruction, models, diagrams, pictures), explicit strategy training (e.g., direct instruction and metacognitive strategies such as monitoring understanding, questioning, predicting), and/or computer-assisted instruction (e.g., videos or tutorials outlining representations or strategies) to boost learning.

Schema-based instruction refers to explicitly teaching a framework for the underlying structure (schemas) of word problems to enhance problem-solving ability. Schemas reflect the semantic and mathematical structure of a word problem and dictate organizational methods for solving the problem (Jitendra et al., 2007). Research suggests schema-based instruction is an effective framework for boosting word-problem solving across whole number and rational number topics, especially among students at risk for mathematics difficulties (Fuchs et al., 2010; Fuchs et al., 2017; Jitendra et al., 2007; Jitendra et al., 2016; Peltier & Vannest, 2017; Wang et al., 2020). With schema-based instruction, students learn the underlying structure of common word-problem types. In elementary school, most word problem types fit into the following schemata (Jitendra et al., 2007; Jitendra & Star, 2011; Marshall, 1995; Mercer & Miller, 2006):

- **Change** (additive): a starting amount increases or decreases.
- **Total** (additive): two different entities are combined.
- **Compare** (additive): compare referent sets.
- **Restate** (multiplicative): assess the relationship between two things.

Effective schema-based instruction explicitly teaches students the similarities and differences across these schemata, and how problem-solving strategies differ by problem type. Students must learn to: identify the problem type; extract relevant information from the problem; ignore irrelevant information; identify the unknown quantity (in variable positions); use knowledge of the problem type to create a model or equation to represent the mathematical relationship; solve the problem; and check whether the solution makes sense (Fuchs et al., 2017; Jitendra & Star, 2011; Mercer & Miller, 2006).

How MyPath K–5 Develops Students' Problem-Solving Skill

Onscreen teachers verbalize how to analyze, represent, and flexibly model real-life problems with mathematics. Lessons across topics and domains use word problems and models to introduce concepts and exemplify the mathematics concept's utility with real-world applications. For example, to engage students in a lesson about interpreting fractions as division, the onscreen teacher

introduces a word problem about sharing five cups of trail mix among four friends. Students watch the video demonstration of how to split five cups (depicted as fraction bars) among four people, each receiving 1¼ cups of trail mix. The onscreen teacher verbalizes the problem-solving process as the animation represents dividing each cup into four equal parts and splitting them equally among the friends. A strong focus on word problems develops students' productive disposition, as these real-world examples enhance students' ability to contextualize the information and recognize the utility of mathematics.

The curriculum explicitly focuses on understanding schemas to devise a meaningful solution strategy. Word-problem solving is broken down into manageable chunks to minimize the learning challenge. For example, the onscreen teacher reads a simple addition word problem about money (end amount missing) and models how to find the answer with base 10 blocks, before introducing a more complex problem (change amount missing) and the problem-solving strategy. Onscreen teachers encourage students to assess the reasonableness of their answers with a range of strategies. For example, students use a range of models, such as pictures, base 10 blocks, and number lines, to model word-problem equations. Lessons also emphasize summary statements (i.e., word-problem labels) to correctly answer questions.

Students learn the "understand, plan, solve, check" framework for approaching different word-problem types. For example, an onscreen character named J.T. incorrectly solves a two-step problem, and his friend Rita reminds him of the steps needed to solve word problems. She walks him through the problem-solving process, teaching him how to a) understand the problem; b) choose a strategy to solve the problem; c) use the strategy to solve the problem; and d) look back and check work. See below for an example:

- **Understand** (Figure 103): "Create a summary statement that includes the word problem label, to answer the question and assess whether the answer makes sense. Create a chart that includes what you know and what you need to know to assess the problem type."
- **Plan** (Figure 104): "Think about what's happening in the story and model the word problem with a diagram, table, or equation. If you're having difficulty, try guessing and checking or working backward. Sometimes you may even need to use more than one strategy."
- **Solve** (Figure 105): "Use the plan and your knowledge of operations to solve the problem." For example, Rita models showing her work to solve the multistep word problem requiring both addition and multiplication.
- **Check** (Figure 106): "Write the answer in the summary statement to determine whether it makes sense, based on the context of the answer. Students assess whether their answer matched their expectations." For example, Rita verbalizes that the problem requires multiplication, so the answer should be greater than either factor (and differentiates this from J.T.'s initial incorrect solution). She also models using knowledge of operations to check her multiplication with division and check her addition with subtraction.

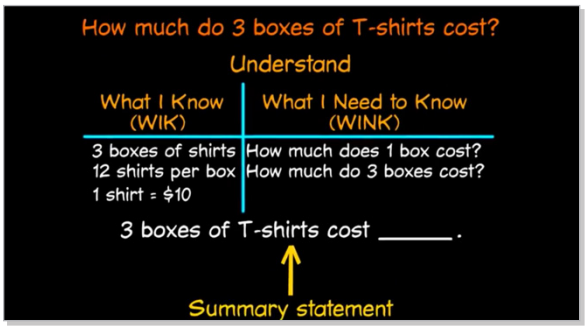


Figure 103. Students in K–5 learn to summarize word problems using a chart.

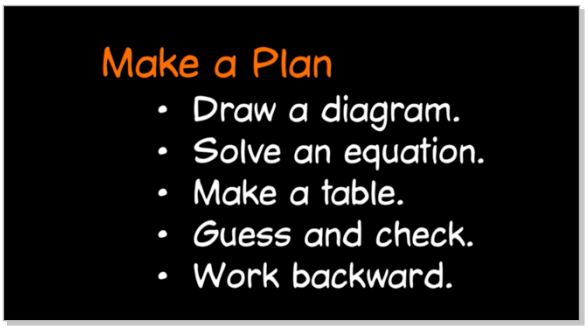


Figure 104. Students in K–5 learn how to make a plan to solve a word problem.

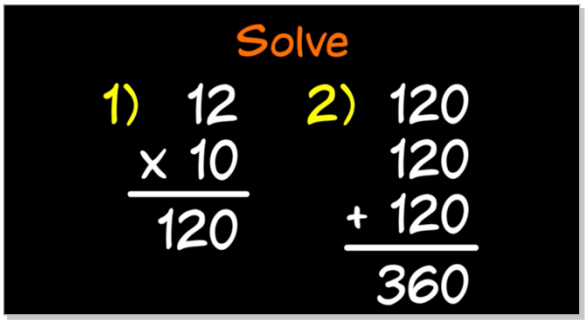


Figure 105. Students in K–5 learn multiple solution strategies to solve a word problem.

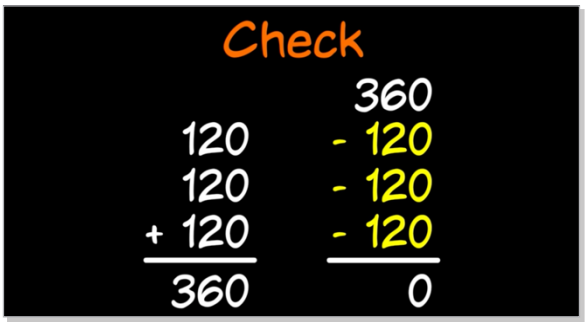


Figure 106. Students in K–5 learn how to check whether their answer makes sense.

The curriculum introduces relevant word-problem types (e.g., **Change** [Figure 107], **Total** [Figure 108], **Compare** [Figure 109], **Restate** [Figure 110]) in isolation. Students learn how to recognize the underlying structure of each problem type and see various strategies to solve the problem. Once the curriculum introduces all relevant problem types for the students' ILPs, practice becomes interleaved. Students must be able to differentiate the underlying problem-solving structure to solve the problem successfully. For **Change** and **Total** problems, lessons incorporate examples with the missing amount in various locations in the equation (e.g., varying whether the start, change, or end amount are missing). Students use models (e.g., base 10 blocks, number lines) and knowledge of operations to solve for the missing number. This emphasizes algebraic reasoning and the relational meaning of the equal sign.

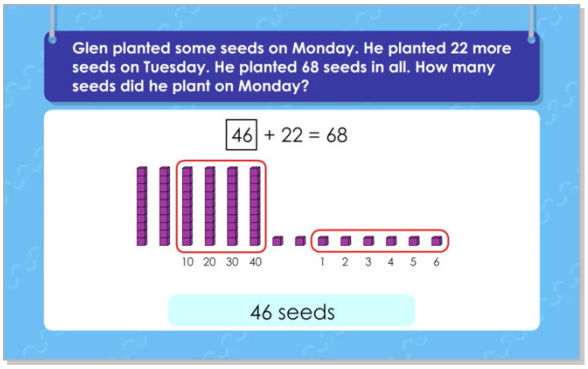


Figure 107. Students in the K–2 band learn to solve Change word problems.

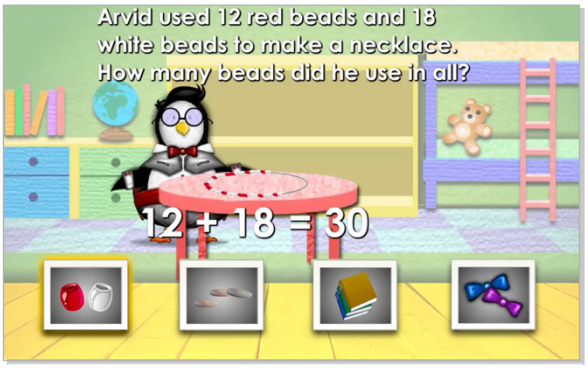


Figure 108. Students in the K–2 band learn to solve Total word problems.

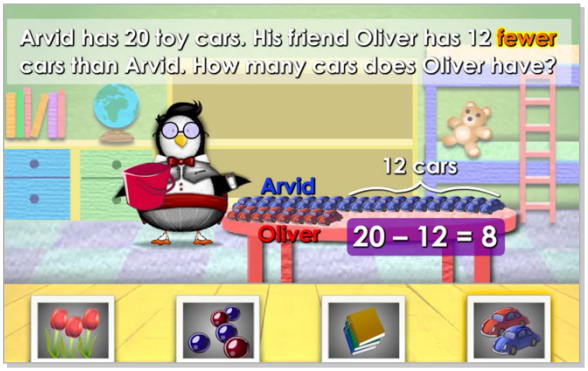


Figure 109. Students in the K–2 band learn to solve Compare word problems.

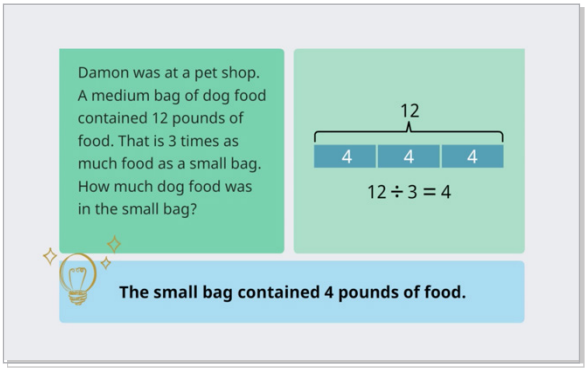


Figure 110. Students in the 3–5 band learn multiplicative reasoning.

Principle 5: Deliver Actionable Data to Inform Instructional Decision-Making

Data-driven decision-making is imperative for evaluating instructional effectiveness (Knapp et al., 2006). Achievement (universal screening and summative assessment) and progress-monitoring data (formative assessment) enable educators to assess students' responsiveness to instruction and make important instructional adaptations to meet the needs of all students (Fuchs & Fuchs, 2015, 2016; Gersten, Beckman, et al., 2009; Gersten, Compton, et al., 2009; National Center for Learning Disabilities, n.d.; NRC, 2012; RTI Action Network, n.d.; Stoiber & Gettinger, 2015).

If data indicate students are not adequately responding to high-quality whole-class instruction, students require supplemental instruction that prioritizes the foundational skills necessary to efficiently and effectively get back on track (Fuchs et al., 2017). Research suggests that supplemental instruction should use a cyclical data-based decision-making process to drive instructional intensification and improvement to meet students' needs. This cycle includes universal screening, assigning research-based instructional protocols matched to student needs, using frequent progress-monitoring data to inform instructional adaptation when students do not respond, analyzing whether this adaptation improved student performance, and quickly acting to intensify instruction, if needed (Fuchs et al., 2017; Gersten, Compton, et al., 2009; Gersten, Beckmann, et al., 2009; Hamilton et al., 2009; National Center on Intensive Intervention, n.d.).

In fact, in a study testing the efficacy of an adaptive mathematics program, teachers who interacted with student data dashboards reported feeling more informed and better prepared to intensify instruction (Ysseldyke & Tardrew, 2007). Research suggests that progress-monitoring data are most effective when used to motivate students to take ownership of their learning by clearly communicating learning goals, providing immediate feedback, assessing progress, and recalibrating goals as needed (NRC, 2012).

How MyPath K–5 Capitalizes on Actionable Data to Inform Instructional Decisions

Screening, formative, and summative assessment data enable teachers to efficiently identify student strengths and weaknesses, make informed decisions about instruction, and supplement the student's ILP as needed. The priority mapping and continuously adaptive system support teachers in an increasingly time-intensive, individualized, and data-driven world. Teachers and administrators gain actionable insights on student progress and engagement with various reporting tools, empowering them to make data-driven decisions to individualize and intensify intervention to accelerate students' progress. MyPath K–5 supports the cyclical data-based design-making process within Response to Intervention (RTI) and Multi-Tiered Systems of Support (MTSS) frameworks with comprehensive data reports and integrated assessments of and for learning.

The program integrates proprietary **MyPath K–5 Assessments**, which include a universal screener and summative assessments, to reliably and validly measure students' strengths and weaknesses in reading and mathematics. The MyPath Assessments are multistage and fully adaptive assessments that measure skills in multiple content domains spanning Grades K–12 reading and mathematics.

- **MyPath Assessments* (screener, benchmark, posttest):** Data generated from these assessments support data-based decision-making at the classroom, school, and district level, including assessing need and responsiveness within the RTI/MTSS framework. Each assessment includes an introduction and three testing stages (with rest breaks in between), designed to be completed in one class period (approximately 60 min). The introduction includes an interactive and age-appropriate activity that primes students to take the test. Then students complete three adaptive stages that present a personalized set of multiple-choice and technology-enhanced items targeting their current skill level. Students respond to approximately 30 to 45 items across all three stages, with test length varying across grades and for individual students to ensure an accurate representation of current skill level. Screener data calibrate students' ILP. (Teachers have the opportunity to review ILPs to ensure they are the best fit for each student, as test data can vary day to day and week to week.) Benchmark and posttest data indicate responsiveness to instruction (and recalibration of ILPs, if needed).

*Note MyPath K–5 can also integrate data from NWEA® MAP® Growth, Renaissance Star®, or teachers' input to set and adjust ILPs, should schools choose not to administer the MyPath Assessments.

- **Formative assessments:** Integrated mastery checks assess students' knowledge of the content within and across lessons. These formative assessments drive the adaptivity of the curriculum by targeting skill gaps as they emerge and allowing students to skip content they have already mastered. There are three five-item assessments within each lesson (two assessments in the *Early Literacy Bundle*s and reading foundations lessons). Students can test out by mastering the first or second assessment. Teachers can see students' progress at the domain and skill level in real time, allowing them to intervene as needed.

The program also includes a range of educator-facing reports to assess progress and implementation fidelity. Each of these reports can be viewed at the classroom, school, or district level so teachers and administrators can assess progress at various levels.

- **Teacher dashboard:** This user-friendly interface provides an overview of progress on content mastery ("students to focus on" and "lessons to focus on") and usage (implementation fidelity) among students enrolled in the class (Figure 111). Teachers can click on individual students to see their progress along their ILP (e.g., number of lessons completed, number of mastery checks passed and failed, number of lesson attempts). For example, the teacher clicks on Jesus's progress report (Figure 112) and sees he struggles with multiplication (multiple failed lessons). The teacher can click into a specific lesson to see the number of attempts, answers on each of the mastery-check items, and whether the student needs reteaching (after three failed attempts). The teacher can use these data to inform instruction by working with Jesus individually, grouping students with similar difficulties, or reviewing multiplication with the whole class.
- **Placement reports:** Teachers can see an overview of assessment data, the number of students who placed below, at, or above grade level, and the placement level of their ILPs. These data update with each benchmark assessment. Teachers can also access each individual student's ILP progress at the domain and skill level in reading and mathematics.

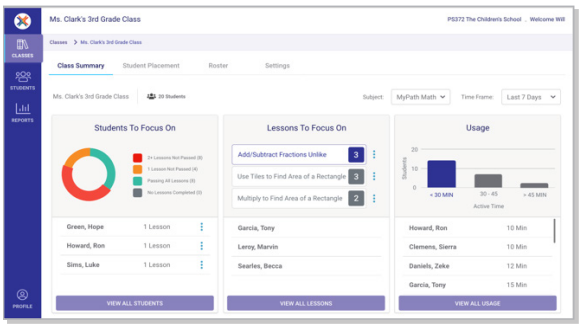


Figure 111. The teacher dashboard provides actionable insights into content mastery and usage.

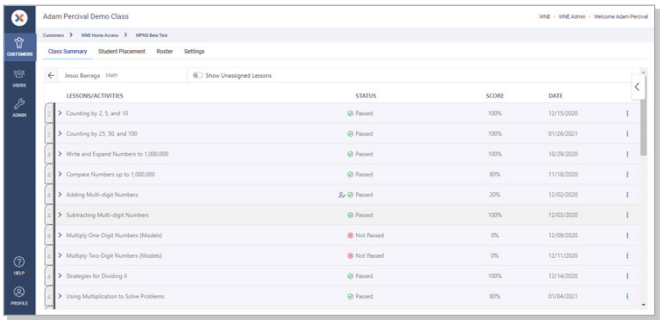


Figure 112. Teachers can see each individual student's progress on their ILP.

Principle 6: Optimize Student Motivation and Engagement

Self-efficacy, positive self-concept, and motivation significantly affect academic achievement (Gunderson et al., 2018; Moller et al., 2009; Valentine et al., 2004). Self-efficacy refers to students' confidence in controlling internal factors, including motivation, achievement, and energy (Bandura, 1997). "Self-efficacy is hypothesized to promote appropriate task choice, persistence in the face of difficulty, and, ultimately, achievement" (Gunderson et al., 2018, p. 1135). Positive self-concept refers to students' belief that they can complete a task successfully, and is highly related to domain-specific knowledge (Moller et al., 2009). Experiences of success and failure affect students' motivation to persist with difficult tasks, which in turn affects their motivation and self-regulation (Bandura, 1997). Research suggests actively addressing students' self-efficacy, self-concept, and motivation to boost, with the following instructional-design principles:

- Model self-monitoring and goal-setting behavior in the context of cognitive strategy instruction (Harris et al., 2015; Wang et al., 2019).
- Assess progress with a formative assessment so students can take charge of their learning, improve their growth mindset, and reassess goals as needed to support the productive struggle toward attaining rigorous grade-level standards (Fuchs et al., 2021; Graham & Harris, 1989; Kim et al., 2021; Wang et al., 2019).
- Provide systematic and explicit instruction with ample opportunities to demonstrate success, to improve students' self-efficacy and persistence with challenging tasks (Archer & Hughes, 2011; Margolis & McCabe, 2004; Usher & Pajares, 2008).
- Integrate gamified motivational elements such as points, badges, and progress reports to enhance motivation, engagement, and academic achievement (Alshammari, 2020; Bai et al., 2020). Adapt these elements to match learners' preferences (Alshammari et al., 2016).
- Promote behavioral engagement (actions students take during learning) and psychological engagement (cognitive processing required to learn) to enhance learner outcomes (Clark & Mayer, 2016).

How MyPath K–5 Optimizes Student Motivation and Engagement

MyPath K–5 promotes self-efficacy and positive self-concept with an engaging, interactive learning environment that rewards students for making progress and motivates them to persist, even with challenging content. For example, even when students do not pass a mastery check, they receive positive reinforcement for attempting the challenge (e.g., "Nice effort! Let's get some more practice. You'll be an expert in no time."). Motivating reinforcement varies. Students earn points even for failed attempts, allowing them to unlock customization features within the digital program (e.g., backgrounds, sidekicks). If a student fails more than three lessons, their ILP recalibrates to minimize frustration and ensure they experience success.

Onscreen teachers model self-monitoring and goal-setting behavior. For example, in a reading lesson, the onscreen teacher asks questions such as, "Do you see any evidence?" and "Do you see any clues?" to prompt students to actively monitor their reading comprehension. Metacognitive bubbles appear during guided practice to remind students to monitor their comprehension. Frequent progress monitoring (i.e., mastery checks within the lessons) allows students to assess their learning-goal progress. Students visually track their progress on a map within the ILP home screen (Figure 113) and the Fun Center (Figure 114), with levels to demarcate progress.

The interactive curriculum incorporates points, badges, rewards, and sidekicks. Students earn points (stars) to unlock customization features. They trade in points for new sidekicks (Figure 115) and new backgrounds (Figure 116) to personalize their ILP. The more points they earn, the more customization features they unlock (Figure 117). The customization features do not distract students from the learning material. The program incorporates encouraging and celebratory prompts to motivate students to productively struggle with challenging learning material before a mastery check (Figure 118), if they fail (Figure 119), and if they pass (Figure 120). These engaging features promote a growth mindset and persistence.

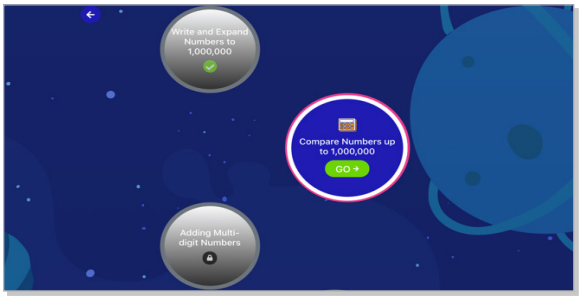


Figure 113. Students visually track their progress on a map on their ILP home screen.

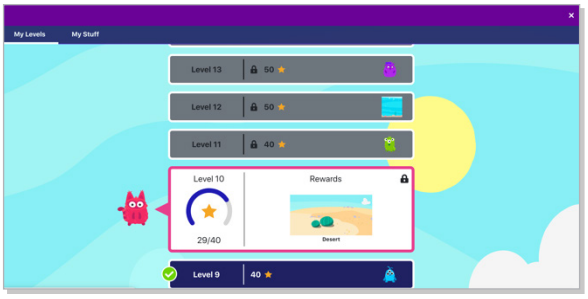


Figure 114. Students have access to a Fun Center that tracks their progress.

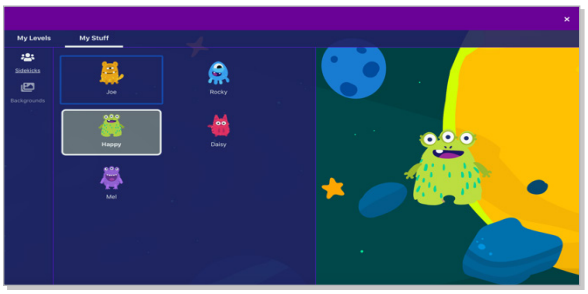


Figure 115. Students trade points for new ILP sidekicks.

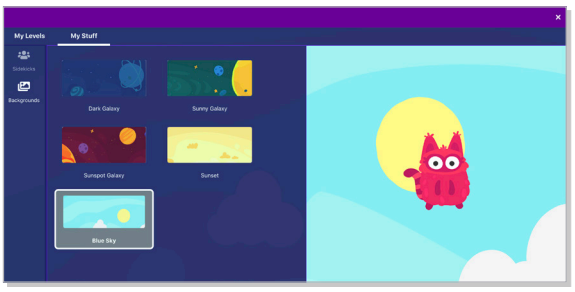


Figure 116. Students trade points for new ILP backgrounds.

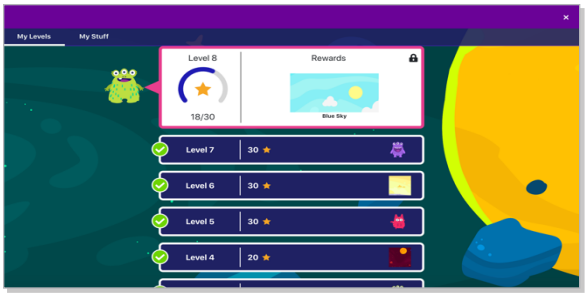


Figure 117. The more points students earn, the more customization features they unlock.

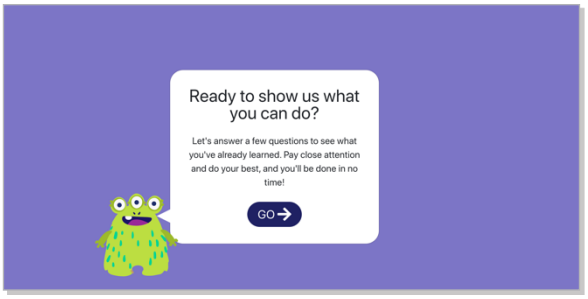


Figure 118. Encouraging prompts motivate students to work hard.

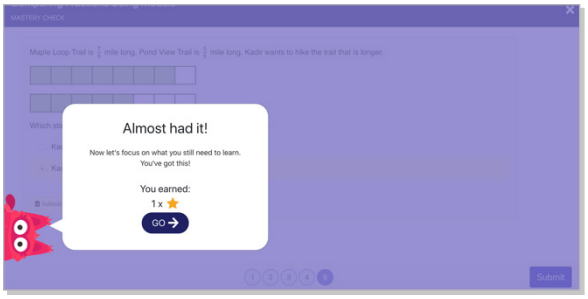


Figure 119. Students receive positive reinforcement to persevere through challenging content.

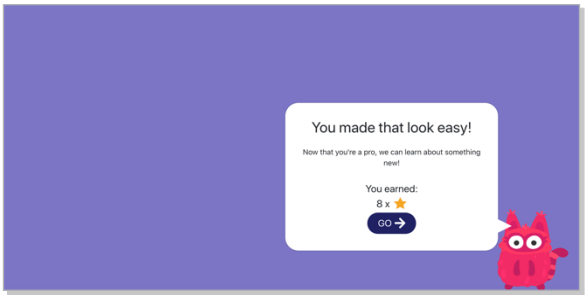


Figure 120. Students receive positive reinforcement to continue learning along their ILP.

MyPath K–5 promotes behavioral engagement with various multimedia presentation formats, teaching styles, and response options. Behaviorally engaged, interactive tasks support the cognitive learning process (e.g., connecting already-learned content to new content, concept mapping), boosting effectiveness. To promote psychological engagement, lessons provide timely and effective instruction to fill the gaps and monitor each student's progress to gain insight on their most pressing needs. Lessons incorporate activation of prior knowledge, strategy instruction, and self-explanation of material. Age-appropriate presentations ensure struggling learners stay motivated to learn.

Conclusion

Edgenuity's MyPath K–5 efficiently boosts student achievement by incorporating research-aligned principles in reading and mathematics and utilizing Smart Sequencer™ technology to prioritize content and continuously adapt learning based on student performance. Instruction is accessible, explicit, and scaffolded to minimize cognitive load and ensure students can develop metacognitive strategies to regulate their learning. Reading lessons prioritize reading foundations (i.e., code-based skills) and reading comprehension (i.e., meaning-based skills), with a strong focus on improving reading comprehension across expository and narrative text. Mathematics lessons prioritize conceptual understanding of whole numbers and rational numbers, algebraic reasoning, and problem solving. Students learn concepts with a range of representational models before procedures to enhance procedural fluency. Mathematics problem solving is rooted in real-world contexts to increase engagement. Teacher data dashboards offer actionable insights on student progress and difficulties, optimizing data-based decision-making. Student data dashboards, rewards, positive behavioral support, and customizable features motivate students to track their progress and take charge of their learning.

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