



Scaffold-Up: Supporting All Students in Achieving Mathematics Proficiency

Twenty-first century mathematical standards emphasize the need for students to acquire strong critical thinking, problem-solving, reasoning, and communication skills. When today's students become adults, they will face new demands for utilizing math skills at a level previous generations have not. All students must become proficient in mathematics to ensure college and career readiness (National Research Council, 2001). Unfortunately, National Assessment of Educational Progress (NAEP) results for 2019 showed that only 41 percent of fourth-grade students and 34 percent of eighth-grade students scored at or above the NAEP Proficient level in mathematics. To ensure proficiency, educators must support all students in accessing and mastering rigorous-grade level content.

The National Research Council (2001) defined mathematics proficiency with the following strands:

- *conceptual understanding*—comprehension of mathematical concepts, operations, and relations
- *procedural fluency*—skill in carrying out procedures flexibly, accurately, efficiently, and appropriately
- *strategic competence*—ability to formulate, represent, and solve mathematical problems
- *adaptive reasoning*—capacity for logical thought, reflection, explanation, and justification
- *productive disposition*—habitual inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one's efficacy

To ensure more students become math proficient, mathematics instruction should be research-based, align with mathematics standards, and be proven effective for supporting proficiency in mathematics. The Institute of Education Science (Gersten et al., 2009) reported that effective instruction for students who have yet to demonstrate grade-level proficiency in mathematics should address screening and monitoring students' progress, include explicit instruction and in-depth treatment of whole and rational numbers, focus on problem-solving strategies, use visual representations of math, and include motivational strategies for students.

Assessment and Individualized Pathways

Assessing students' performance is key to providing appropriate instruction. The purpose of administering assessments is to provide accurate information on student progression toward mastery of educational standards and to guide instructional decisions (Herman & Baker, 2005).

Imagine Math benchmark assessments align with the Quantile Framework®, which provides an objective measure of each students' ability and readiness to learn new math skills and concepts. Assessments are seamlessly integrated within Imagine Math to maximize testing efficiency. Quantile Framework assess-



ments are administered at the beginning, middle, and end of the school year and provide educators with data to monitor and track students' progress toward mathematical proficiency.

When students begin Imagine Math, placement tests help establish their learning pathways. These tests are designed to assess student learning and inform instructional pathways. Because the goal of instruction is to support all students in achieving success with rigorous, grade-level mathematics, learners start their journey with grade-level content and receive precursor lessons (if needed) based on diagnostic assessment outcomes. Other intentional scaffolds include "Math Help" features and on-demand access to certified, bilingual Live Teachers who provide real-time strategic instructional support to students at the point of use. Learning pathways are then individualized based on students' performance and their ongoing demonstration of proficiency.

Explicit Instruction

Explicit instruction is systematic and includes modeling of new skills, demonstration of strategies for solving problems and complex tasks, guided practice with feedback, and support for concept formation with examples and non-examples (Smith, Sáez, & Doabler, 2016).

Imagine Math provides explicit instruction and guidance as students practice new skills and advance in learning mathematical concepts. Instructional approaches within lessons align with best practices for teaching specific mathematical concepts. Within lessons, students are directly taught new skills and vocabulary and then guided in applying learning. For example, when learning *length*, students are taught what *length* is, how to identify *length*, and are then guided to practice identifying *length* for objects shown. As students complete practice problems, they receive feedback that is immediate, instructive, and corrective. Students interact with models, illustrations, and animations to build conceptual understanding. Throughout Imagine Math, lessons incorporate these facets of effective instructional sequences to promote successful learning.

Systematically Designed, Coherent Instruction

Systematically designed instruction addresses foundational learning before moving to complex skills and concepts (Gersten et al., 2009). Essential components of systematic instruction include mastery of pre-requisite skills before introducing new learning and providing sufficient practice necessary for skill acquisition and mastery.

Mathematics instruction is coherent when the development of foundational and advanced skills are integrated across grades and the progression of skills makes logical sense in terms of when topics are introduced and sustained across grades and educational experiences (Schmidt, Houang, & Cagan, 2002).

Imagine Math instructional sequences provide foundational skills such as cardinality and number sense prior to exposing students to more complex math concepts. For example, early learners encounter the concept of size (*big and small*) before they compare and order the size of objects. Students in later elementary grades and middle school grades learn to add time in five-minute intervals before they learn to add and subtract time using number lines, clocks, and tables. Across grades, instruction is coherent and topics such as whole numbers and number operations are addressed across multiple grades with increasing complexity.



To ensure students have prerequisite skills necessary for new learning, they complete pre-tests before engaging with lesson content. If students do not demonstrate foundational understanding of lesson concepts, they complete pre-requisite lessons before engaging with sequenced lessons.

Conceptual Understanding

Conceptual understanding refers to understanding mathematical concepts and recognizing their application in various situations. Students who have yet to demonstrate proficiency in math need strong foundations in number sense and must gain the ability to work with whole and rational numbers. Learners in kindergarten through fifth grade need an in-depth understanding of whole numbers including counting, number composition and decomposition, place value, math facts, and the reasoning associated with algorithms for addition and subtraction. Students in grades three and above need to acquire an extensive understanding of rational numbers including fractions, decimals, ratios, percent, and how to solve problems involving rational numbers. (Gersten et al., 2009). Once students acquire fundamental understanding of these concepts, instruction should then focus on applying understanding in novel situations.

Imagine Math provides robust instruction that supports the development of conceptual understanding across foundational and advanced mathematics topics. As learners in grades PreK-2 complete lessons that build number sense and conceptual understanding of numeric operations, they complete activities that extend learning in new applications. For example, as students learn basic number compositions for 6, they apply this unique concept in a variety of activities that require them to compare quantities, equations, and use different combinations of numbers to add and subtract for the quantity 6.

Students in grades 3 and above complete lessons in numbers and operations with fractions, statistics and probability, working with polynomials and rational expressions, number operations in base ten, measurement and data, algebraic operations and thinking, and geometric properties and equations. All lessons are presented with multiple visual representations of concepts to support students in conceptual understanding. To further this goal, Imagine Math application activities provide opportunities for older students to apply learning to real-world problems so that they better understand how mathematical knowledge can be applied to problems they might encounter in their daily lives.

Math Fact Fluency

Math fact fluency is the ability to rapidly and accurately recall facts associated with the four math facts operations: addition, subtraction, multiplication, and division (Nelson et al. 2016). Recalling math facts with automaticity is important for later math success as the development of automaticity directly relates to cognitive load and efficiency when doing math (Fuchs et al. 2005). If students are not fluent with math facts, they will expend cognitive resources when solving complex math problems that inhibit their ability to efficiently complete problems (Barrett & Carter, 2017).

Imagine Math Facts is an immersive, game-like learning experience in which students advance as they demonstrate mastery of specific math facts. Imagine Math Facts is designed to quickly build math fact fluency—the primary indicator of algebra readiness for students in first through fifth grade. Students' differentiated learning begins immediately in Imagine Math Facts with a pre-test that assesses prior math skill and competency.



Based on the results of the pre-test, learning paths and instructional time are adjusted so that students spend more time on material appropriate for their individual skill level. As students progress in the program, learning tasks adapt to student performance so that they receive an appropriate mix of review and fluency building activities. When needed, students are shown models of specific facts. Throughout the program, feedback is immediate and corrective, which facilitates accurate recall of math facts. Imagine Math Facts is highly engaging for students and motivates them to progress through the entire program and achieve fluency in less than five hours.

Instructive Feedback

Providing instructive feedback on student performance is one of the most powerful instructional methods used in teaching. Immediate, corrective feedback informs students of whether their responses are correct and reduces the likelihood that students will practice errors (Gersten et al., 2009; Smith, Saez, & Doabler, 2016). Performance feedback should occur immediately following students' responses.

All feedback provided in Imagine Math is immediate so that students know whether their answers are correct or incorrect. When students answer questions correctly, they receive verbal praise, motivation, award-points, and reinforcement of concepts with visual diagrams, explanations, and models. If students answer incorrectly, they receive verbal and visual indicators that the answer is incorrect. Then they are provided with explanations of the concepts including visual representation, diagrams, and models to prompt students to self-correct. Following corrective instruction students have the opportunity to answer correctly.

Visual Representation

To become proficient in mathematics, students must develop the ability to fluidly and automatically process various forms of mathematical expressions including visual, concrete, and symbolic representations of mathematics as well as understand language-based expressions used in word problem. Students who experience difficulty with math often struggle to understand relationships between visual representations of math and mathematic symbols. The systematic use of visual representations in learning math may lead to significant and positive gains in math proficiency (Gersten et al., 2009).

Imagine Math visually represents mathematical concepts in all lessons. For students in grades PreK-2, instructional sequences introduce concepts using concrete, representational, and abstract models. For example, in learning number and cardinality, kindergarten students are shown a word problem represented by cute pictures before moving to symbolic models such as circles or squares, and then they progress to numeric equations. As students advance in elementary grades, concepts are presented visually and spiraled to build mastery toward symbolic processing.

Students in grades three and above can access visual supports with number lines, graphics, diagrams and graphs, and a full suite of digital math tools. These tools support students in learning to work with various representations of mathematics. As students complete problems, learning is reinforced with visual representations of concepts. When students answer problems correctly, they review the visualization of the problem. Visualizations are also used to provide corrective feedback for improving math performance.



Scaffolding and Live Teachers

Instructional scaffolding refers to supports or assistance provided to students that enable them to complete tasks with high rates of success that they may not otherwise complete independently. Mathematical scaffolding refers to instructional support for procedural skills, conceptual understanding, metacognitive strategies, and mathematical practices (Moschkovich, 2015).

Imagine Math PreK–2 includes a wide range of scaffolds that support conceptual understanding and procedural skills including visual representation of concepts, contextualized vocabulary instruction necessary for learning math concepts, verbal directions and instruction, and spiraled practice that supports students in mastering concepts before gradually increasing the difficulty of practice items.

Imagine Math 3+ provides a progressive system of scaffolds to support successful learning. Students are provided with models, illustrations, and animations of specific concepts. When needed, students can access “mini-lessons” that further illustrate concepts and new skills. A variety of supports are available to help students learn including an online calculator, a formula reference guide, and a multi-lingual glossary.

Students can also access rigorous real-time instruction with live, on-demand certified bilingual teachers to obtain help for specific problems. Live teachers chat with students and provide instructions and visual models and illustrations via a two-way interactive whiteboard to help students successfully engage with math problems.

Student Engagement and Motivation

Building proficiency in mathematics involves deep engagement in problem-solving, reasoning, and critiquing mathematical practices (Lambert & Sugita, 2016). There is a direct correlation with engaged learning and increased achievement in mathematics—the more students engage with mathematics, the more they learn.

All Imagine Learning solutions are designed to engage students in meaningful learning. Imagine Math is instructionally engaging, requiring students to interact frequently as they solve math problems. Students interact in a variety of ways including clicking on objects, moving objects, and using formulas and math tools to calculate answers to problems. Animations and game-like presentation are particularly engaging for students across all grades.

Imagine Math 3+ provides a unique motivational system for students. As learners complete problems, they earn points when they answer questions correctly. Their points can be tracked on school or program leaderboards, contribute to classroom goals for learning, and be used for charitable contributions and avatar customization. As students accumulate points, they determine how to spend points earned—whether to use them in virtual worlds or to donate them to causes such as the American Red Cross, Wounded Warrior Project, or Boys and Girls Clubs of America. Points donated to charities can result in donations being made on students’ behalf. Additionally, students can participate in contests sponsored by Imagine Learning that allow them to earn extra points and help to receive national recognition for their school or class.



Conclusion

Mathematics instruction should be research-based, align with mathematics standards, and be proven effective for supporting proficiency in mathematics. Imagine Math is intentionally designed to provide scaffolding that enables all students to access rigorous grade-level instruction. Instruction is individualized to meet students' needs, systematic in developing conceptual understanding, procedural and fact fluency, and applied in supporting students' problem solving and reasoning ability. Imagine Math supports like live-certified teachers and visualized representations of math ensure students can access and be successful learning grade-level mathematics.

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