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HOW WE SOLVE AMERICA'S MATH CRISIS: A Systemwide Approach to Evidence-Based Math Learning

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EXECUTIVE SUMMARY

Math achievement across the United States is in crisis, with too many students leaving school without the essential math skills they need to thrive in adulthood. COVID-19-era disruptions deepened this issue in recent years, driving national scores to their lowest levels in decades and increasing gaps for students from low-income backgrounds, students of color, girls, English learners, and students with disabilities. **The good news is that this problem is solvable, and the solutions are clear. We already know what works to improve math learning – the challenge is that proven practices have not been implemented consistently or widely adopted.** Without immediate action to develop, implement, and sustain systemic changes, too many students will have their futures stunted before they even graduate.

Mathematics education is about much more than memorizing formulas or solving equations; it forms the foundation for critical thinking, problem-solving, and data literacy – key skills students need to succeed in today's world. Early struggles in math compound over time, limiting access to advanced coursework in high school, narrowing college and career pathways, and ultimately restricting entry into higher-wage careers.

Effective math instruction has three key components. It should (1) build educator and student math identity and a shared belief that math is doable, (2) balance conceptual understanding and procedural fluency while also creating meaningful opportunities for real-world application, and (3) ensure that learning progresses logically and cumulatively to deepen knowledge over time. However, decades of reforms – including new standards, curricula, and professional development – have fallen short because their implementation has been fragmented and disconnected from how students learn math.

This report identifies the need for a systemwide commitment to an evidence-based approach to teaching math, similar to the movement to align reading instruction with the cognitive science behind how students learn to read (often referred to as the "science of reading"). Students will not benefit from this knowledge until the conditions are created that foster the consistent use of these evidence-based practices. However, challenges in and out of the classroom constrain the widespread and consistent implementation of high-quality math instruction. At a systems level, an unclear vision of high-quality math instruction, rigid or poorly designed instructional materials, and frequently changing curricula often lead teachers to use instructional practices that focus on covering material quickly rather than helping to build a deeper understanding of math concepts. In classrooms, limited professional development and coaching, inconsistent use of formative assessments, and an educator's own conceptual knowledge and math identity can further restrict instruction, reducing opportunities for students to develop flexible thinking, collaboration, and a strong mathematical identity.

Moving forward, education leaders must focus on system-wide coherence that supports teachers by establishing a clear, shared vision of effective math instruction and developing structures, resources, and supports that align with that vision. First, **establish a clear, shared vision of effective math instruction** that defines what high-quality teaching and learning look like – and how it supports math identity, understanding, and fluency. This vision provides a unifying anchor for the math instructional strategy, ensuring alignment across the school system – from leaders to coaches and classroom teachers. Once the vision is in place, **create systems and resources aligned with that vision** by auditing current standards, curricula, and assessments to identify gaps or misalignment. Everything must be aligned to reinforce the same instructional goals, which are always connected to the vision. Over time, **ensure that structures support the vision** by building cohesive professional learning systems that include professional development and collaboration structures for developing content knowledge and provide opportunities for learning strong instructional practices.

These steps may seem familiar, and that's because they are widely accepted best practices for developing and sustaining strong instructional design. However, to be effective, they must be consistently applied over time and throughout the system. Some schools and school systems are already applying these principles, and the results show the promise of this approach: **Data demonstrate that when high-quality materials, intentional instructional practices, and strong teacher support are combined, students' math proficiency can improve significantly** — even in schools starting with very low baseline scores.

Improving math outcomes is an urgent challenge of our era, but it is one we know how to address. It will require a collective effort to apply what we understand about how students learn math, connect that to what we know about effective instructional practices, and then consistently and comprehensively implement these strategies over a sustained period. This report examines three evidence-based instructional strategies that drive student learning: (1) building educator and student math identity and their belief that math is doable, (2) balancing conceptual understanding and procedural fluency while also creating meaningful opportunities for real-world application, and (3) ensuring that learning progresses logically and cumulatively to deepen knowledge over time. The report also outlines what practices aligned with these strategies look like in action, as well as the system-wide supports — including a strong instructional vision, high-quality instructional materials, curricula, professional learning and coaching, and data-driven decision-making — that enable effective teaching.

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Introduction

What was your experience as a math student? Did it involve memorizing facts and formulas, while listening to a teacher walk through step-by-step solutions? Did an adult ever implicitly or explicitly suggest that you or other students in your class just weren't math people? For many of us, math class was something to get through by rote memorization and abstract explanations. But high-quality mathematics education is far more than recalling formulas or solving algebraic equations; it is a way of making sense of the world. It is the practice of understanding patterns,[1] in recognizing relationships between concepts and ideas, and solving problems using logical thinking.[2] When done well, math instruction prepares all students to question, connect, and creatively solve real-life challenges in our data-driven world.

Despite the importance of math, over half of America's students are not proficient in the subject.[3] Only 39% of fourth graders and 28% of eighth graders achieved proficiency in 2024.[4] This longstanding challenge deepened during the pandemic, which drove National Assessment of Educational Progress (NAEP) math scores to some of their lowest levels in over 20 years.[5] Despite decades of reforms, including but not limited to new curricula,[6] professional learning requirements for teachers,[7] and changes in course sequencing,[8] math outcomes continue to lag, especially for students from low-income communities, students of color, girls, English learners, and students with disabilities.[9] Progress has been stalled by poor implementation, including inconsistent use of instructional materials,[10] insufficient teacher prep and support,[11] and limited use of evidence-based instructional practices.[12] Addressing systems-wide challenges to ensure all students have access to high-quality math instruction is imperative, as it opens doors to postsecondary academic and economic opportunities and prepares students to thrive in a world shaped by math-based data and technology.

Students' persistent underachievement in math raises an essential question: How do students best learn math concepts, and are teachers receiving the support they need to meet students' learning needs? This question closely echoes those addressed by the "science of reading," an interdisciplinary body of research that explains how the human brain learns to read and identifies effective instructional strategies based on that knowledge. Early successes among states adopting science of reading reforms[13] offer valuable lessons for mathematics instruction, underscoring the potential of a similar evidence-based movement in math.

This report offers educators and leaders a road map to improve student learning and achievement in math through evidence-based practices. It highlights both what students need to reach proficiency in math and what leaders and teachers must do to make that possible. Research points to three essential components of math education:

1. Building educator and student math identity and belief that math is doable.[14]
2. Balancing conceptual understanding and procedural fluency in instruction while also creating meaningful opportunities for real-world application.
3. Ensuring that learning progresses logically and cumulatively to deepen knowledge over time.[15]

But effective student learning and math instruction do not happen by chance. They require an intentionally designed instructional ecosystem with strong instructional leadership, high-quality instructional materials, professional learning and coaching, and data-driven decision-making that supports effective teaching and learning.

"[Students] struggling because of the quality of education, the quality of instruction ... I mean, we have just ignored all of the research. It is clear that the reason things are not working comes down to a structure that doesn't have the key support elements for teachers."

Steve Leinwand, Principal Research Analyst and Mathematics Expert, American Institutes for Research

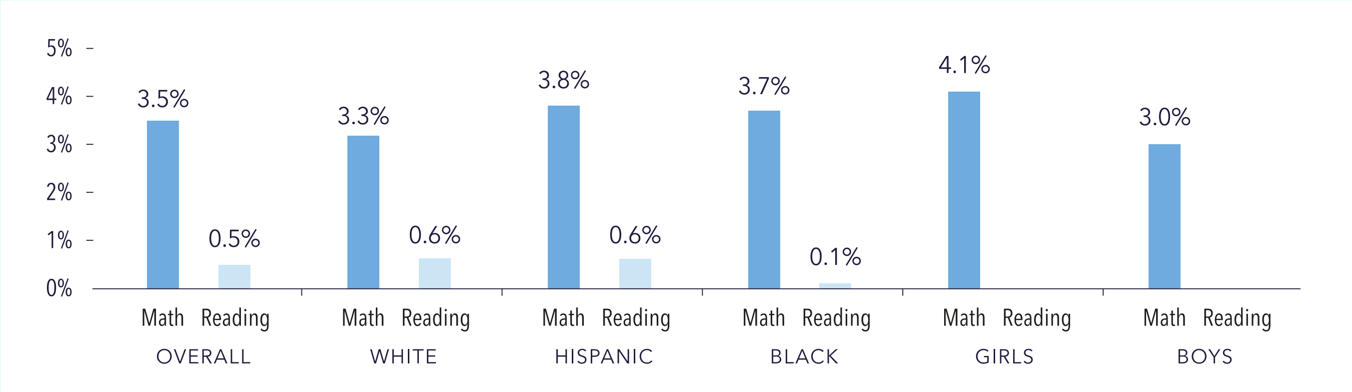
Low Math Achievement in School Has a Lifetime of Consequences

Math achievement in school is one of the strongest predictors of long-term economic success. Students who develop strong math skills early are more likely to pursue advanced training after high school[16] and enter careers that offer stability and growth.[17] Specifically, the Urban Institute found that raising math scores by age 12 is associated with significantly higher earnings at age 30, even more so than comparable gains in reading.[18] Conversely, students who struggle with math are more likely to be tracked into lower-wage jobs.[19]

According to the Georgetown Center on Education and the Workforce, by 2031 nearly 85% of all new jobs in the U.S. will require some form of postsecondary education.[20] Many jobs will require some math reasoning, and individuals with math-intensive careers, such as data scientists working in emerging artificial intelligence (AI) technologies,[21] earn significantly higher wages compared with those in lower-wage positions.[22]

Mathematical proficiency also affects well-being in everyday life beyond the workplace. Adults with strong math skills are better equipped to budget, avoid high-interest debt, and plan for retirement.[23] By contrast, those with weaker math skills are more likely to struggle with everyday tasks such as paying bills, calculating discounts, or even reading a bus schedule.[24] They may also face greater health risks because they may find it challenging to interpret health data. Just as literacy is essential for understanding language in its many forms, numeracy is equally important for making sense of the world of numbers and data.

Figure 1. Percent Increase in Earnings at Age 30 With Improved Math Scores (0.5 SD) by Age 12



Source: The Urban Institute report. The term "math scores" refers to children's achievement in mathematics up to around age 12, expressed in standard deviation units relative to the general population. Used as a proxy for academic achievement within the Social Genome Model (SGM 2.1), these scores help simulate how a 0.5 standard deviation increase impacts later-life outcomes, such as earnings at age 30. Not tied to a single test like NAEP or state assessments, "math scores" represents a composite of standardized math proficiency measures from longitudinal datasets feeding into the SGM.

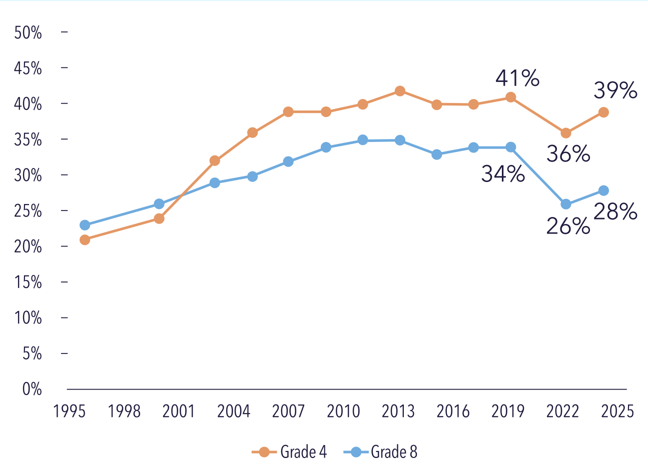
Early struggles in math achievement deepen over time, and gaps in elementary skills such as number sense and fractions mean that students cannot access higher-level skills or coursework.[25] They are more likely to have difficulty in middle school algebra, limiting their opportunities to access advanced math courses in high school and ultimately diminishing their readiness for postsecondary success.[26] Students in marginalized groups are particularly vulnerable to the long-term effects, as there are often fewer supplemental supports for them if they are not immediately successful. Their schools often experience higher teacher turnover[27] and have less access to rigorous instructional materials and advanced coursework.[28] Students in high-poverty schools are less likely to be enrolled in Algebra I in grade 8, which is a key gateway course for higher-level instruction.[29]

Moreover, systemic tracking practices, which sort students into different academic pathways (e.g., remedial, standard, honors, or advanced), often disproportionately exclude students of color from gifted or advanced math courses.[30] By college, many of these students who have not yet developed math proficiency are placed into remedial math classes, which require tuition but don't count toward a degree. Of the 60% of community college students who are placed in at least one remedial course, with math being the most common, fewer than 20% go on to complete their degree within eight years.[31] As a result, they show higher attrition rates from college, increased debt, reduced degree attainment, and less access to higher-wage careers.[32]

Math Achievement in America Is Declining

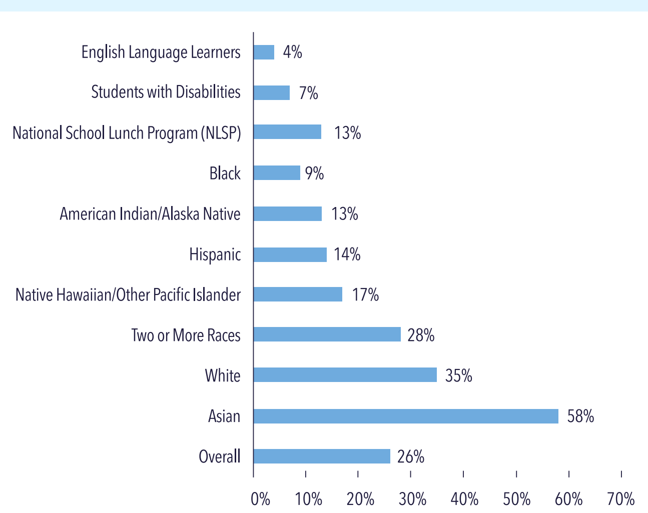
Over half of all American students are not proficient in math. In 2024, only 39% of fourth graders[33] and 28% of eighth graders[34] scored "at or above proficient" in math on the NAEP (Figure 2). Math achievement has always been inconsistent, but recent data from national and international assessments show a sharp decline in math achievement for all students, with gaps widening during the pandemic, especially for marginalized groups. In 2022, only 36% of fourth graders[35] and 26% of eighth graders[36] scored "at or above proficient" in math on the NAEP, the lowest scores in over two decades. Although 2024 data suggest some improvement, these declines still represent a meaningful setback and effectively erase a decade of progress in math achievement.

Figure 2. Percentage of Grade 4 and Grade 8 Students at or Above Proficient on the NAEP Over Time[37]



In addition, students with disabilities, English learners, students of color, and students who are economically disadvantaged lag persistently and disproportionately behind their peers.[38] Nationwide, only 9% of Black eighth graders and 14% of Hispanic eighth graders scored at or above proficient, compared with 35% of White eighth graders. English learners, students with disabilities, and students from low-income families show similarly low outcomes (Figure 3).[39] These numbers are staggering. They don't just reflect individual struggles; they highlight systemic challenges and enduring inequities in the way math is taught and supported across schools and communities.

Figure 3. Percentage of Eighth Graders at or Above Proficient on the NAEP by Student Group in 2022 [40]



Even before the pandemic, students in the U.S. were losing ground in math. Results from the Programme for International Student Assessment (PISA), an exam given to 15-year-olds in over 80 countries every three years by the Organisation for Economic Co-operation and Development (OECD),[41] highlight this challenge in the global context. Unlike many standardized tests that focus on procedural skills, PISA measures math literacy, or how well students can quantitatively reason, analyze data, and solve unfamiliar real-world problems. Scores are reported on a six-level proficiency scale ranging from Level 1c (solving only simple, routine problems) to Level 6 (tackling abstract, complex problems with creativity and flexible thinking). In 2003, U.S. students averaged a score at Level 3. By 2022, that average had fallen to Level 2 and was below the OECD average.[42] These results signal that U.S. students not only struggle to move beyond basic math skills but are falling behind their international peers in the higher-order reasoning and problem-solving that today's data-driven world requires.

Across America, low math achievement is persistent, with most students, especially the most vulnerable, leaving school without the skills they need. This chronic low achievement is due, at least in part, to a hundred years of rapid changes in our thinking about how to teach math and how that churn has inhibited stable implementation.

How We Got Here: A Century of Shifts in Mathematics Instruction

Over the past century, math instruction has evolved significantly, influenced by shifting beliefs about how people learn, political factors, and the growing demands for advanced mathematical knowledge (Figure 4). Math instruction focused on rote memorization to meet industrial-era needs[43] in the early 1900s and transitioned in the 1950s through the 1970s to prioritize more advanced concepts through the "New Math" movement. Spurred by the launch of Sputnik and national security concerns, this movement pushed for more advanced and abstract math to bolster the United States' scientific and technological competitiveness.[44] However, many teachers were untrained in these new methods, and families found the content difficult to grasp.[45]

The 1983 report *A Nation at Risk*, commissioned by the Reagan administration, highlighted that a lack of rigor in math education threatened national security and economic strength.[46] It called for stronger graduation requirements (such as a minimum of three years of math), improved teacher preparation, and increased accountability through regular testing.[47] These recommendations led to the development of the National Council of Teachers of Mathematics (NCTM) standards in 1989, which emphasized deeper conceptual understanding, problem-solving, reasoning, and real-world math applications.[48] These reforms sparked the "Math Wars," igniting debates over curriculum priorities as traditionalists argued that the reforms sacrificed procedural fluency, while reformers contended that procedural skills without conceptual understanding left students unprepared for modern demands.[49]

In response to these conflicts, the Common Core State Standards were introduced in 2010 as an effort to promote a balanced approach. They emphasized both deep conceptual understanding and procedural skills for students, as well as fostering a strong math identity – the belief that all students can do math.[50] The rollout of these standards was highly ambitious and faced a number of implementation challenges, including political pushback, uneven implementation, and limited teacher support. Many critics viewed these standards as federal overreach,[51] and most districts lacked truly aligned curricula[52] and introduced new assessments before teachers and students were prepared.[53] In addition, the mandated professional development was inconsistently implemented.[54] As a result, national achievement data showed little improvement across all student groups. Then, in 2020 the pandemic introduced new setbacks, with disruptions in learning leading to historic declines in math achievement overall and widening opportunity gaps, particularly among marginalized subgroups of students.[55] Systemic recovery efforts, such as high-quality math teaching, are critical to remediating these learning gaps.

Math instruction has shifted dramatically over the past hundred years. For many adults, this has led to confusion and even frustration as they try to make sense of their own experiences as math learners in comparison with the approaches their children encounter today. Although these shifts reflect a growing and more sophisticated understanding of how students learn mathematics, they also often have been marked by significant and sudden changes in direction, many of which have not been uniform or consistently supported. This next chapter of math education will be vital to closing achievement gaps and accelerating learning for all students.

Figure 4. History of Math Instruction Timeline, United States

Early 1900s **Rote and Procedural**	1950s-1970s **Launch of Sputnik**	1980s ***A Nation at Risk* Report**	1990s-Early 2000s **NCTM Standards**	2010s **Common Core Standards**	2020-Now **Post-COVID**
Math instruction emphasized rote memorization and procedural fluency, preparing students for factory and military jobs but leaving many without deep conceptual understanding.	Sputnik's launch spurred reforms emphasizing abstract concepts like set theory. However, limited teacher training and unclear real-world connections hindered success.	*A Nation at Risk* report was released, highlighting the need for higher math achievement, teacher prep, and accountability.	The release of the NCTM standards emphasized conceptual understanding and problem-solving, sparking backlash from those concerned that procedural fluency was being neglected.	Common Core introduced rigorous, coherent standards to balance conceptual understanding and procedural fluency, while strengthening students' math identity.	COVID-19 disrupted learning, widening opportunity gaps. Recovery requires high-quality instruction grounded in research and equitable access to rigorous opportunities.

A Science of Math: Grounding Math Instruction in Research

In the early 2020s, the phrase "science of reading" emerged from academic and policy circles to become a household term and a driver of legislative reform.[56] Increasing recognition of the scientific basis for literacy acquisition has highlighted the importance of basing instruction in a rigorous, interdisciplinary body of research rooted in an understanding of human cognition and the mechanics of learning.[57] In literacy, this evidence has clarified our collective knowledge of how children learn to decode, build fluency, and understand text, resulting in significant policy changes and widespread reforms in teacher training and curriculum design. More than 30 states have now passed laws or adopted policies that require schools to align early literacy instruction with the science of reading.[58]

In parallel, the concept of a science of math describes an equally significant body of evidence that is shaping how schools, policymakers, and communities approach math instruction. For the purposes of this report, a "science of math" refers to the growing body of cognitive science research about how students best learn math and how educators can most effectively teach it. While the science of reading highlights phonemic awareness, phonics, and comprehension,[59] emerging science of math research highlights that high-quality instruction (1) builds both educator and student math identity, fostering the belief that math is doable,[60] (2) balances conceptual understanding and procedural fluency while also creating meaningful opportunities for real-world application, and (3) ensures that learning progresses logically and cumulatively to deepen knowledge over time.[61] These evidence bases aim to ground instruction in rigorous research about human cognition and provide guidance for improving instructional practices, curriculum design, teacher development, assessments, and educational policies.[62]

The following sections of this report look at what the research reveals about teaching and learning in classrooms. We explore how students learn math and provide a road map to support all educators in better aligning instructional practices, system practices, and professional learning so that all students have the chance to grow their math proficiency.

The goal is for all students to achieve proficiency, and the science of math provides a roadmap for how to teach it effectively.

CLARIFYING TERMS:

"The Science of Math" vs. a Science of Math

The descriptive term "science of math" refers to a growing and complex body of research on how students best learn mathematics and what instructional practices are most effective. This term is descriptive; it does not refer to any one formal initiative. This evidence base includes a range of studies emphasizing different priorities including conceptual understanding vs. procedural fluency, or discovery learning vs. explicit instruction.

The proper noun "The Science of Math" represents one approach calling for states, districts, and policymakers to align math instruction with a specific body of select evidence from cognitive science and research.[63] To date, there is no single Science of Math approach for which all researchers are aligned.

The Objective of High-Quality Instruction Is to Build Proficiency

Math proficiency is the ability to understand, apply, and effectively communicate math concepts across a range of problems and contexts. To become proficient, students need a combination of skills, knowledge, and attitudes that work together to foster deep mathematical thinking. Contrary to many people's educational experiences, math proficiency is not simply memorizing formulas or procedures. Real proficiency is characterized by the ability to skillfully apply one's conceptual understanding in unique, real-world situations. In order to think and talk about math proficiency with shared language, the National Research Council created a helpful framework that outlines the interconnected strands of mathematical proficiency (Table).[64] When woven together, these strands result in math proficiency.

Table. National Research Council's Strands of Math Proficiency

PROFICIENCY STRAND	WHAT IT MEANS	WHY IT MATTERS
Conceptual understanding	Comprehension of mathematical concepts, operations, and relations.	Students understand why math works the way it does, not just how to perform steps.
Procedural fluency	Knowledge of procedures, when and how to use them appropriately, and skill in performing them flexibly, accurately, and efficiently.	Students perform basic computations with automaticity to preserve cognitive space for deeper thinking.
Strategic competence	The ability to formulate mathematical problems, represent them, and solve them.	Students consider multiple solutions and adjust as needed.
Adaptive reasoning	Capacity for logical thought, reflection, explanation, and justification.	Students think through a problem, make sense of it, and are able to explain how their solution works.
Productive disposition[65]	Habitual inclination to see mathematics as sensible, practical, and worthwhile, coupled with a belief in diligence and one's own efficacy.	Students believe that math makes sense and are confident that they can learn with effort and persistence.

Although parts of this framework may be described or interpreted differently,[66] there is broad agreement that true math proficiency means going beyond procedures to develop deep conceptual understanding, strong reasoning skills, and a positive math identity.

Focusing on individual strands of this framework may lead to incremental changes in math achievement for some students, but true transformation requires sustained focus on overall proficiency. For example, effective curricula should be designed to strike a balance between conceptual understanding and procedural fluency. Instructional materials and practices should also hold time and space to support a strong math identity by building strategic competency, adaptive reasoning, and a productive disposition. Instructional practices must bring together teachers' own mathematical reasoning with their ability to facilitate that learning in students through logical and cumulative learning progressions. Given the complexity of this work, it is no surprise that inconsistent implementation,[67] insufficient teacher preparation and support,[68] and limited use of evidence-based practices[69] have stalled progress in improving student math proficiency.

Overcoming these barriers requires a collective, system-wide commitment that goes beyond individual teachers. Facilitating high-quality math learning is a shared, system-wide effort that requires a clear vision from leadership, strong alignment across teams, and consistent support across all levels. While teachers are expected to design engaging, rigorous learning experiences and help students see themselves as capable mathematicians, system leaders must create the conditions that make this possible by investing in high-quality materials, professional learning, and structures that promote equity and coherence.

How to Deliver the High-Quality Math Instruction That Improves Student Proficiency

Math proficiency describes what students need to learn and be able to do to succeed in mathematics. High-quality instruction describes how all educators work together to create the conditions to facilitate and support that learning. These two ideas work together: Instructional practices should be designed to develop proficiency, and the strands of proficiency[70] should guide educators' thinking around instructional design and support.

Together, the goals of high-quality instruction that builds math proficiency are to (1) build educator and student math identity and their shared belief that math is doable, (2) balance conceptual understanding and procedural fluency while also creating meaningful opportunities for real-world application, and (3) ensure that learning progresses logically and cumulatively to deepen knowledge over time. For each goal, we describe what students need, the aligned high-quality instructional practices, and the system-level supports that enable student and educator success.

1 Build educator and student math identity and their belief that math is doable

Beyond academic implications, low math achievement has social and cognitive impacts. Many students, and even adults, who struggle with math often internalize the belief that they are "not math people." When math is taught as memorizing steps without understanding, learners who struggle may internalize mistakes as proof that they lack ability. Broader cultural messages — such as praising speed over reasoning or the common phrase "I was never good at math" — reinforce the idea that math talent is innate rather than developed. Over time, these influences undermine confidence, create math anxiety, and convince learners that math is a skill for only a select few, rather than something everyone can develop.

What do students need to develop a strong math identity?

Students and educators need to see themselves as math people. A classroom that fosters a strong math identity depends deeply on establishing a growth mindset that is catalyzed by flexible thinking and collaborative learning.[71] These three elements shape not just what students learn, but how they feel about themselves as math learners.

- **Classroom culture that fosters a growth mindset.** Students and all educators should view mathematics as both useful and within their capabilities. Fostering confidence to persist, make mistakes, and learn from those mistakes is essential. A supportive, growth-oriented math environment helps both students and teachers see themselves as capable math learners, increasing their likelihood of staying engaged and taking risks in their mathematical learning.

- **A classroom where flexible thinking is encouraged.**[72] Students and teachers should recognize that problem-solving involves multiple approaches. There isn't just one correct way to solve a problem; in fact, it is beneficial when different people develop their own methods. Math is about strategic and adaptive reasoning, not merely arriving at the right answer. Therefore, students should have opportunities to explore various solution strategies, make mistakes, and learn from them. By embracing productive struggle, students gain flexibility in thinking by working through challenges and reflecting on their solutions.

- **A classroom that has embedded opportunities for collaborative learning.** Students need to learn alongside and from each other in math class.[73] When students collaborate to solve problems, they engage in meaningful discourse that enhances their understanding and reasoning skills. Exposure to diverse perspectives and problem-solving strategies during discourse also supports their conceptual understanding and flexible thinking. Additionally, these interactions provide valuable opportunities for students to articulate and explain their own reasoning, building confidence and a growth mindset.

What should instructional practices and support look like?

Math identity is shaped by every part of the learning experience, not just the content itself. How the content is taught and the environment in which it is delivered are equally important. Without a coordinated approach, efforts to improve students' math identity may become fragmented, leaving students and educators with mixed messages about who is a "math person" and who isn't. A strong, cohesive ecosystem ensures that instructional practices used by teachers and leadership strategies used to support teachers work together to build a positive math identity for everyone.

WHAT ARE THE ESSENTIAL INSTRUCTIONAL PRACTICES?	HOW CAN INSTRUCTIONAL LEADERS SUPPORT?

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Encourage self-reflection to help students become more aware of how they approach problems, the strategies they use, and the challenges they face. This approach aims to deepen their understanding of mathematical concepts and procedures. Additionally, it encourages the development of a mindset that values effort and persistence.[74] Reflection prompts such as *"What part of the lesson felt challenging? How did you work through it? What would you do differently next time?"* can be incorporated into exit tickets, math journals, or even think-alouds or classroom discussions.

Reduce anxiety by **encouraging students to explain *why*** answers make sense instead of focusing on how quickly they were solved.[75]

Normalize making mistakes. Mistakes should be framed as learning opportunities, and instruction should incorporate built-in opportunities to use errors as learning tools.[76]

Encourage mathematical discourse and peer collaboration. Leverage challenging, open-ended tasks that require explanation, acknowledging that multiple valid solutions may exist.[77] Maintain ongoing dialogue through pair work, small group interactions, and whole-class discussions. This culture of group discussions and valuing diverse ways of thinking is especially important for students from groups that may not see their identities reflected in math or STEM, giving them opportunities to share their perspectives and experiences.

Make math relevant by showing students how it connects to their lives, interests, and futures. When students see these connections, they become more motivated to learn, and math feels less abstract or disconnected from real life.[78] Teachers can use real-world examples (such as sports or video games) or frame math as a tool for answering interesting questions to help students see its value.

HOW CAN INSTRUCTIONAL LEADERS SUPPORT?

Create an instructional vision that prioritizes a growth mindset. School and district leaders should believe and communicate that everyone (students, teachers, and leaders) *can* do math with the right support. This vision should be codified to emphasize math identity as essential in school improvement plans, instructional coaching, and team meetings. This mindset fosters a supportive environment where teachers are inspired to develop engaging lessons that build confidence and promote mastery across all learners in math.

Invest in math-specific professional learning, such as lesson study and content-focused workshops to strengthen teachers' knowledge of math content and how students learn it. Professional learning should help educators understand the why behind math, not just the steps.

Implement ongoing, job-embedded professional learning to equip teachers with training on growth mindsets and instructional practices that foster student voice, encourage multiple solution strategies, and build teachers' confidence and belief in their ability to teach math in innovative ways (which may be different from how they were taught or how they typically learn).

Dedicate protected time for collaborative peer support where teachers and instructional leaders can reflect on their classroom practices. This also includes developing strategies to enhance student collaboration, group work, and problem-solving skills.

2 Balance conceptual understanding with procedural fluency while also creating meaningful opportunities for real-world application

Students and teachers must understand *how* to execute procedures accurately (procedural fluency) and *why* procedures work (conceptual understanding). Procedural fluency allows students and teachers to perform math problems efficiently, preserving cognitive space for more complex reasoning. Conceptual understanding helps students and teachers see relationships, apply reasoning, and transfer knowledge to new problems. Without conceptual understanding, students may rely on memorization, leaving them unable to check their work, explain why a solution makes sense, and reflect on their own thinking – skills that are essential for solving more complex problems.

What do students need to build conceptual understanding and procedural fluency?

Research tells us that conceptual understanding and procedural fluency develop together. The more students understand the meaning behind math, the better equipped they are to reason and use higher-order thinking.

- **Students need to understand the "why" of math,** which is conceptual understanding. Having a deep understanding of mathematical concepts helps students (and teachers) make connections between ideas (or *why* a method actually works). In addition, understanding the "why" enables the flexible application of mathematical procedures and helps boost confidence in their ability to problem-solve.

- **Students need the tools and skills to solve basic problems efficiently.** Procedural fluency boosts automaticity (the ability to perform a skill quickly and accurately) and numeracy (the ability to understand and use math concepts in real life). This expands cognitive capacity for applying math to solve problems efficiently, accurately, and flexibly over the long term. This is essential for deep problem-solving[79] and building transferable knowledge and skills.[80]

"CARRYING THE 1"

The idea of "carrying the 1" highlights why balancing conceptual understanding and procedural fluency is so important. Students can be taught the procedure – adding digits in one place value, writing down the result, and "carrying" the extra to the next column – but without understanding why this works, the steps can seem arbitrary and confusing.

$$\begin{array}{r} 47 \\ +13 \\ \hline 0 \end{array} \longrightarrow \begin{array}{r} \overset{1}{4}7 \\ +13 \\ \hline 60 \end{array}$$

Conceptual understanding helps students see that when the sum in the ones place is greater than nine, it represents both ones and a group of tens. The "1" being carried is not a trick but a way of regrouping that ten into the next place value. When students understand the logic behind the procedure, they are more likely to remember it, apply it correctly, and extend the idea to subtraction with regrouping, multi-digit multiplication, or even algebraic expressions. Procedural fluency allows them to use the method efficiently, while conceptual understanding ensures they know why it works – together, both foster lasting confidence and skill in mathematics.

What should instructional practices and support look like?

A balanced approach to math instruction ensures that students become proficient, adaptable, and efficient problem-solvers who can articulate their reasoning clearly and apply math concepts to real-world situations.[81] This approach requires high-quality curricula and multifaceted instructional strategies, such as open-ended tasks, that challenge students with new and complex problems to help build and reinforce both procedural skills and conceptual understanding.[82]

WHAT ARE THE ESSENTIAL INSTRUCTIONAL PRACTICES?	HOW CAN INSTRUCTIONAL LEADERS SUPPORT?
Encourage math talk by asking questions. Ask students questions and give them the opportunity to explain their thinking and engage in discourse.[83] This strategy helps deepen understanding by reinforcing connections between concepts and procedures, especially when discussing multiple solution paths. **Incorporate rich, open-ended math problems** that foster reasoning and sense-making. These types of problems encourage flexible thinking by prompting students to apply their procedural skills in ways that deepen their conceptual understanding. Problems are especially powerful when they allow for multiple solution paths, encouraging varied approaches and richer learning experiences. **Use explicit and intentional instructional strategies such as guided practice, real-time feedback, modeling, and explaining why procedures work.**[84] These strategies are underscored by the teachers' thinking about students' potential questions and solutions to tasks and preparing to push and challenge where appropriate. This helps students build a foundational understanding of procedures and concepts. **Use models and visuals to give students context.** Students need practice with the spectrum of concrete to representational to abstract for sense-making and conceptual understanding.[85] A wide range of tools can be used, including number lines, arrays, whiteboards, Rekenrek (number racks), and blocks to support developing place value.	**Develop professional learning plans that prioritize deep content knowledge and pedagogy.** Professional learning should support teachers in developing a deep understanding of content and pedagogy, as well as best practices and instructional strategies. In addition, principals and coaches are trained and supported to observe math lessons, provide specific feedback, and lead instructional cycles focused on continuous improvement.[86] **Design coaching and professional learning plans that utilize co-teaching or modeling** as a way to support teachers in implementing best practices. This approach will help teachers feel supported and provide real-time feedback and solutions for the effective implementation of these practices. **Ensure access to high-quality, aligned curricula.** The curriculum should be aligned with college and career-ready standards. The curriculum should not change frequently, should provide coherence across grades PK-12, and should be structured to balance conceptual understanding, procedural fluency, and application to reduce the burden on teachers to improve rigor and instructional coherence. **Leverage intellectual preparation.** Teachers who are teaching the same grade level or grade band should have structured time to discuss the underlying goal of the lessons, share questioning techniques, discuss exemplar responses, rehearse lessons, and proactively plan for addressing misconceptions. This creates a space for teachers to test strategies and build confidence and skill in their instruction.

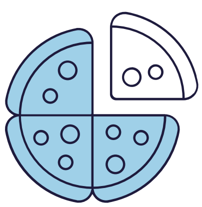
3 Ensure that learning progresses logically and cumulatively to deepen knowledge over time

Learning progressions in math should be ordered intentionally over time so that they are logical and cumulative in order to foster long-term proficiency. When mathematical concepts are introduced in an intentional and connected sequence, students can see how ideas build on one another and use what they already know to deepen their understanding. Because learning is cumulative, each new concept reinforces and extends earlier knowledge. This approach promotes deeper learning, builds confidence, and prepares students for more advanced studies.

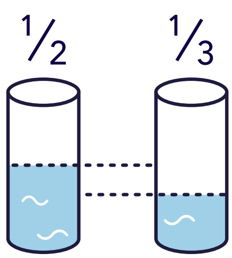
Why do students benefit from logical and cumulative learning progressions?

Research tells us that conceptual understanding and procedural fluency develop together. The more students understand the meaning behind math, the better equipped they are to reason and use higher-order thinking.

Math becomes easier for students to understand when they develop foundational knowledge that builds in complexity over time. When students learn new concepts that connect clearly to what they have already learned, they are more likely to feel confident and capable. Well-structured learning progressions support both conceptual understanding and procedural fluency by helping students see patterns, recognize relationships, and internalize how earlier skills apply to new and complex problems.



The sequence through which students learn fractions demonstrates why logical, cumulative learning is essential in math. Early in elementary school, students learn that fractions represent equal parts of a whole – such as dividing a pizza into halves or quarters.



As they progress, students compare fractions (e.g., understanding that one-half is greater than one-third), which requires both conceptual understanding and number sense. They then learn to add and subtract fractions with like denominators,

$$\frac{1}{3} + \frac{1}{3} = \frac{2}{3}$$

and later with unlike denominators, a skill that depends on understanding equivalent fractions.

$$\frac{1}{2} + \frac{1}{3} = \quad \begin{matrix} \frac{1}{2} = \frac{1\times3}{2\times3} = \frac{3}{6} \\ \frac{1}{3} = \frac{1\times2}{3\times2} = \frac{2}{6} \end{matrix}$$

$$\frac{3}{6} + \frac{2}{6} = \frac{3+2}{6} = \frac{5}{6}$$

In middle school, these foundational skills extend to multiplying and dividing fractions, strengthening links between whole numbers, ratios, and proportional reasoning.

$$\frac{1}{2} \times \frac{1}{3} = \frac{1\times1}{2\times3} = \frac{1}{6}$$

Ultimately, these cumulative skills prepare students for algebra, where fractions relate directly to rational expressions and equations. Without a logical progression, gaps – such as misunderstanding equivalent fractions – can make mastering later concepts much more difficult.

What should instructional practices and support look like?

WHAT ARE THE ESSENTIAL INSTRUCTIONAL PRACTICES?

Understand the developmental trajectory of math concepts across grades, including what students should already know, what comes next, and how these concepts connect over time.[87] Teachers are then better able to support students who enter the grade at varying proficiency levels and effectively guide them to the next stage of learning. This will also help teachers sequence lessons to build on prior knowledge and deepen understanding over time by revisiting ideas.[88]

Teach the curricula-aligned standards with fidelity. Teachers should understand how standards and curricula operate together. This helps in understanding how the concepts are sequenced to support learning over time, including when concepts should be mastered and identifying opportunities to introduce concepts earlier.[89]

Use data-informed decision-making (including formative assessments) to identify learning gaps and develop a plan to address them.[90] Regularly collecting and using formative assessments, such as common-unit assessments, can help teachers understand where students may be struggling and enable them to adjust their instructional approach. Formative assessments are also important for giving real-time, rapid feedback to students and for adjusting instructional materials (e.g., exit tickets).

Collaborate with other math teachers across grades to align instruction and ensure students experience connected learning year after year.[91]

HOW CAN INSTRUCTIONAL LEADERS SUPPORT?

Dedicate time for collaborative peer planning and support. This protected time can be used for grade-level content teams to meet regularly to analyze student work, lesson plan, and reflect on instructional practices. This time should also be used to review student data and discuss what could be done differently based on the needs of the specific students in their classes.

Ensure that the curriculum and instructional materials are well aligned. The curriculum and pacing guides should be aligned with standards and have a clear scope and sequence. They should introduce mathematical concepts in a coherent order, with each new idea building on prior knowledge and laying a solid foundation for future learning.

Ensure access to aligned professional learning. Professional development and coaching should focus on increasing content understanding and use of data to best understand what and how students are learning and to help tailor lessons to where students are in their current understanding.

> "[High-quality math instruction] is not about a product or the curriculum itself. You need people who understand the curriculum design and content to coach teachers. Instruction becomes higher quality when teachers study the lesson, analyze student work, and respond in an ongoing way to improve student outcomes."
>
> **Joanne Lee Hill**, Math Achievement Director, KIPP

Addressing Barriers to High-Quality Math Instruction

We know what students need to thrive in mathematics: instruction that builds a strong math identity, balances conceptual understanding with procedural fluency, and follows a coherent learning progression. We also know that, despite this evidence from years of research, math achievement remains both low and uneven. Why is that, and why does it persist?

There are challenges in the classroom, and there are also broader system-level barriers that constrain the implementation of high-quality math instruction. In classrooms, teachers' beliefs about math, instructional practices, and inconsistent use of student data can reduce opportunities for students to develop a strong mathematical identity and proficiency. At a systems level, an unclear vision of high-quality math instruction and misaligned instructional support and resources often leave teachers without the guidance they need to support effective student learning.

Addressing these challenges requires intentional, aligned action from educators and instructional leaders who can address teacher math identity and mindsets, shift the focus on instructional practice, and improve the use of data for instruction. In addition, leaders must also commit to providing the necessary systems-level alignment and support so that these efforts are not isolated or fragmented and have the runway to succeed across an entire school or school system.

AI, Math Instruction, and Math Careers

Artificial intelligence (AI) is a tool that is increasingly becoming a part of our daily lives. Its influence on the skills students will need, particularly in mathematics, is also evolving. AI tools can easily handle many procedural tasks and make decisions or predictions that have historically required human intelligence. As AI advances, today's students will experience a workforce where mathematical reasoning skills are critical across careers. Strategic competence will be necessary for students to critically engage with AI technologies and make informed, responsible decisions. In addition, careers in rapidly advancing AI technology such as generative AI (e.g., ChatGPT), robotics and autonomous systems (e.g., Waymo), and the development of artificial general intelligence will demand advanced math, adaptive reasoning, computing, and problem-solving skills. Math education must adapt by fostering conceptual understanding, strategic competence, and digital literacy, especially in ways that meet workforce and civic needs.

In the context of teaching, especially teaching math, AI will undoubtedly reshape how teachers approach instruction. For example, AI tools can help to:

Create more space for deeper learning. AI can take over more manageable tasks such as grading student work or supporting procedural practice. This could give teachers more time to focus on creating robust opportunities for student discourse.

Provide timely, tailored feedback for students and teachers. AI can recognize patterns and give real-time feedback to students and teachers on their work (e.g., Khanmigo, M2 by Swivl). This will allow teachers to better leverage formative assessments to understand how students are progressing on their work. AI can also suggest tailored support tips and follow-up questions based on each student's individual needs. This can give teachers a jump start on understanding where students are and providing timely feedback to ensure students are consistently being challenged without being discouraged or disengaged.

Create innovative content for students to support deeper thinking. AI can create standards-aligned practice problems, word problems, and assessments that are differentiated for various skill levels.

> "It is clear that the litany of reasons that things are not working [in math instruction] comes down to a structure that doesn't have the key support elements for teachers, and therefore inadequate instruction."
>
> **Steve Leinwand**, Principal Research Analyst and Mathematics Expert, American Institutes for Research

Address Teacher Math Identity and Mindsets

Teachers' beliefs about math – their abilities and their students' potential – often play a crucial role in shaping classroom culture.[92] Teachers lacking confidence in their math knowledge or instructional skills may view math as rigid or intimidating and may unintentionally pass this mindset on to students. Similarly, a teacher's lack of conceptual understanding can have a profound impact on math instruction. It shapes how math is taught, how students experience learning, and how misconceptions are addressed. Without professional development that addresses knowledge and mindset, teachers may pass math anxiety on to students, undermining their math identity. To support teachers effectively, instructional leaders can consider the following strategies:

- Invest in professional development that centers on mindset, helping teachers explore their own experiences with math and build confidence in teaching concepts and procedures.
- Invest in math-focused professional learning to help fill the gaps in content knowledge for teachers. Professional learning should help educators understand the "why" behind math, not just the steps.
- Create a safe space for vulnerability and growth, encouraging teachers to reflect on their own math learning journey and identify how students learn best today.
- Foster an environment where teachers feel comfortable trying new strategies, asking questions, and gradually enhancing their instructional fluency.

"The best teachers I know are always learning," Joanne Lee Hill, Math Achievement Director at KIPP said. "Sometimes that means relearning the conceptual understanding behind the math they learned in a procedural way before they can facilitate learning for their children. Sometimes it's learning what a student truly understands before adjusting their approach. Teachers thrive when they feel empowered to grow alongside their students."

Shift the Focus of Instructional Practice

When teachers do not have a deep understanding of the content, classroom instruction often centers on speed and correctness, which can reduce math to mere compliance. This emphasis – often reinforced by testing pressures – limits students' chances to explore content deeply, develop flexible strategies, and collaborate effectively. Additionally, teachers tend to teach in ways they were taught themselves. When lessons are overly scaffolded, students are protected from productive struggle, which research shows is crucial for long-term understanding. Instructional leaders, coaches, and teachers can begin to change practices by:

- Promoting open-ended, rigorous tasks that prioritize reasoning over mere computation.
- Encouraging productive struggle by giving students the opportunity to solve a problem before explaining the solutions or formally introducing the concepts. This allows teachers to build on students' thinking and guide the class toward the lesson's learning goal.
- Incorporating student discussions and peer collaboration into lessons to normalize diverse strategies and encourage math discourse.
- Allocating time within pacing guides for exploration and reflection, rather than just coverage.
- Equipping teachers with practical strategies to integrate conceptual questions, model reasoning, and challenge students to think deeply – moving away from a focus on simply getting the "right answer."

By emphasizing depth, this approach helps students become flexible thinkers who genuinely understand math at its core.

Improve Data-Driven Decision-Making

In many classrooms, data remain underutilized or disconnected from daily instruction. Teachers often lack the time, resources, or training to use data effectively, which means opportunities to adapt instruction in real time are missed. Collaborative structures for examining student work are often limited or inconsistently applied, leaving teachers without a clear picture of learning trajectories across grades. Instructional leaders can help bridge this gap by:

- Offering comprehensive training on designing and implementing formative assessments, including strategies to identify misconceptions and adapt instruction accordingly.
- Establishing systems and routines that encourage teachers to regularly review student work, not just during scheduled benchmark cycles.
- Creating and protecting time for teachers to come together for collaborative planning sessions and integrating data discussions into those sessions so that teachers can reflect on student understanding, strategically group students, and plan targeted interventions.

By elevating the role of data in the classroom, educators can personalize instruction more effectively, address learning gaps in real time, and ensure steady progress for every student.

Commit to System-Level Alignment and Support

Tackling these challenges relies on creating and sustaining a unified ecosystem defined by clear instructional priorities, aligned resources, and supportive classrooms and structures, as they're all mutually dependent. To ensure the alignment of instructional priorities and provide support to overcome these challenges, system leaders can:

- **Create a shared vision.**
  - Develop a shared, instructional vision for math that clearly defines what high-quality teaching and learning look like – and how they support math identity, understanding, and fluency. This vision should serve as an anchor for the math instructional strategy that is understood vertically from leaders to coaches and classroom teachers.
- **Create systems and resources that align with the vision.**
  - Reframe accountability systems to prioritize growth and reasoning, rather than just speed and accuracy.
  - Audit curriculum and pacing guides to ensure they are standards aligned, have logical learning progressions, promote conceptual understanding, and incorporate evidence-based practices.
- **Create structures to support the vision.**
  - Build cohesive professional learning systems with sustained follow-through, aligning professional development, coaching, and collaborative planning to reinforce instructional goals.
  - Establish robust collaboration structures, such as vertical alignment teams and intellectual preparation meetings, to ensure consistency across classrooms and grade levels. These teams should allocate dedicated time for collaboration.

Implementing these actions signals that math instruction is a strategic priority and that systems are in place to support teachers in doing their best work.

> "Show me the best schools you've ever been in, and teachers have PLCs and teachers share. There is simply a culture that says we're all in this together, that comes from the [school leader], and they understand that that's his or her job to do that. It can't be done by the principal alone. Can't be done by teachers alone."
>
> **Steve Leinwand**, Principal Research Analyst and Mathematics Expert, American Institutes for Research

High-Quality Math Instruction in Action

Many math curricula, supplemental materials, and professional development programs aim to address these challenges by incorporating different elements of high-quality math instruction. Some programs, for example, target students' productive disposition and engage students in mathematical discourse. Others aim to improve math proficiency by targeting teacher practice through coaching and intensive curriculum mapping. Although no program is a standalone one-size-fits-all solution, purposefully combining multiple evidence-based programs can create a cohesive approach that improves teacher practice and student math proficiency.

Here are three examples of high-quality math in action and the research-based elements these programs incorporate. Illustrative Math and ST Math are designed to enhance math instruction with high-quality instructional materials. K12 Coalition's Lavinia Group Instructional Support offers a comprehensive professional development program designed to help educators foster a culture of excellent math teaching.

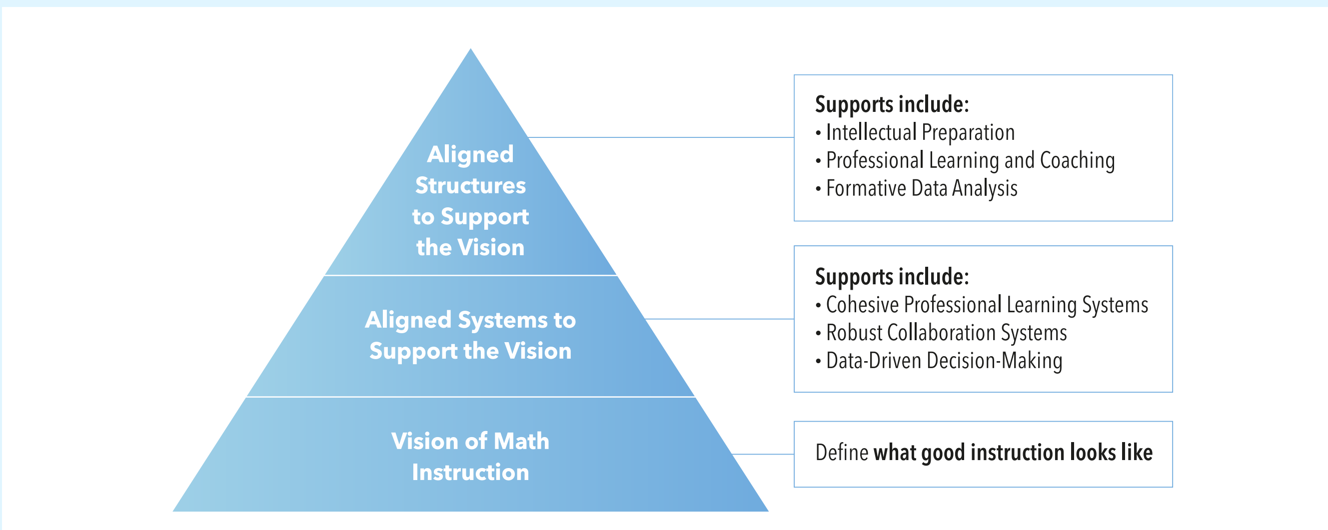
	PROGRAM TYPE	DESCRIPTION	INCORPORATED ELEMENTS OF HIGH-QUALITY MATH INSTRUCTION
Illustrative Math[93]	Curriculum	A curriculum with strong attention to conceptual progression, representation, and assessment alignment.	• Focuses on conceptual understanding in lessons using open-ended problems • Standards aligned with coherent learning progressions • Promotes mathematical discussion and the development of mathematical language through collaboration
ST Math by MIND Research Institute[94]	Supplemental	A game-based, visual learning platform that makes abstract math concepts concrete and aims to build lasting confidence in math.	• Enhances students' conceptual understanding through nonverbal visual learning • Supports individual student practice and productive struggle through the use of puzzles
K12 Coalition's Lavinia Group Instructional Support[95]	Comprehensive Professional Development	Math professional development that emphasizes coaching and teacher planning. It is practice based and designed for immediate classroom implementation.	• Champions teacher collaboration • Ensures curriculum-to-standards alignment • Promotes teachers' reflection and preparation to continuously build their content knowledge • Anchors teacher practice in a rapid improvement cycle

This section takes a closer look at K12 Coalition's Lavinia Group Instructional Support, an approach to developing leaders and teachers in math instruction as an example of how a comprehensive, evidence-based professional development program can put these ideas into action and improve outcomes by addressing both classroom practices and the systems that support math instruction.

Since 2015, K12 Coalition's Lavinia Group division has partnered with over 180 education systems representing over 750 school sites to overcome the persistent challenges that have contributed to our nation's math crisis. Lavinia Group specializes in addressing many of the systemic and classroom challenges that hinder the implementation of high-quality math instruction. Grounded in "a vision of excellent math instruction that fosters both academic achievement and a positive math mindset,"[96] the team supports systems-level leaders through strategic program design, high-quality professional learning and curriculum resources, and hands-on classroom coaching (Figure 5). Through this comprehensive approach, supported schools have seen measurable gains in student achievement.

When working with school partners, Lavinia Group begins by establishing a shared vision at the district and/or school level. The group then works with partners to strengthen the systems that support that vision by **building leaders' and teachers' understanding of math content and pedagogical skills through professional learning; cultivating a culture of collaboration; and establishing progress monitoring systems to measure student proficiency in conceptual understanding, procedural fluency, and reasoning**. Next, the Lavinia Group coaches continue the professional development into the classroom using the Rapid Improvement Cycle, a model for supporting teachers through a cycle of intellectual preparation, modeling or real-time coaching, and data analysis and planning with student work and assessment data.

Figure 5. Description of Lavinia Group Instructional Coaching Approach to Change



Establish a Clear, Shared Vision of Math Instruction

Effective teaching and strong instruction begin with a clear vision and are sustained by aligned systems to support that vision. Lavinia Group aims to help instructional leaders set the direction for improvement by defining the qualities of effective math teaching at the district, school, and classroom levels. Once this vision is outlined, instructional coaches help partners translate that vision into action by establishing systems that coherently support the partners' goals. Given that new initiatives often disrupt old systems and ways of working, the coaches work closely with partners to develop comprehensive change management plans and engage staff throughout implementation.

> "If I could wave a magic wand, I would start with a written, shared, common vision. A vision of effective teaching and learning not only describes what teachers should be doing, what teachers [as well as students and leaders] shouldn't be doing."
>
> **Steve Leinwand**, Principal Research Analyst and Mathematics Expert, American Institutes for Research

Create Systems and Resources to Support the Vision

Build Cohesive Professional Learning Systems. Once a clear vision has been established, Lavinia Group coaches work to design a professional learning scope and sequence that prepares teachers to implement highly-effective math instruction that matches the district or school vision. This professional learning builds teachers' capacity by ensuring that they deeply understand math at a conceptual level and are prepared to implement the essential instructional practices that lead to highly effective math instruction. Lavinia Group coaches also support teachers to deeply understand state standards and how they align with their selected high-quality instructional materials. In doing so, Lavinia Group builds partners' conceptual understanding, procedural fluency, and math mindset, which are critical to effective instruction, given that how teachers are being asked to teach may differ from how educators may have learned math as students.

At Lavinia Group, capacity-building extends beyond those in the classroom to school leaders because strong instructional leadership is critical to support the shared vision. Lavinia Group partners with all levels of leaders, instructional coaches, and content area leads to build their knowledge to support curriculum and standards-aligned instruction. Instructional leaders' professional development is targeted to help build leaders' coaching capacity, improve their facilitation of intellectual preparation and data study meetings, increase the quality of their classroom observations and feedback, and guide the team as change agents through instructional shifts.

Establish Robust Collaboration Structures. Although many schools schedule collaborative planning time, it is often insufficient and lacks structures that foster true collaboration. For instance, rather than using collaborative time to deeply investigate math content and learning outcomes, most collaborative planning is overly focused on discussing operations and logistics and preparing physical materials (e.g., making copies). As a result, teachers may plan lessons together but rarely engage in peer feedback that drives continuous improvement. Effective systems of support and collaborative peer planning can unite teachers around a shared vision, model strong math practices, and ease teachers' math anxiety. Lavinia Group partners with schools through hands-on learning sessions that model instruction and promote relationship-building, collaboration, and communication. By strengthening a culture of collaboration among educators, Lavinia Group aims to lay the groundwork for similar practices to take root among students.

Prioritize Data-Driven Decision-Making. To foster ongoing growth and close the gap between professional learning and classroom execution, research recommends that educators engage in continuous improvement and progress monitoring.[97] Yet, when trying to implement such systems, many educators experience inconsistent implementation or may not have access to formative assessments that are appropriately aligned with their high-quality instructional materials. Lavinia Group addresses these challenges by helping partners set both short- and long-term goals and establish consistent ways to measure progress. By building coherent progress monitoring systems that help teachers understand where students are in their learning progression, prompt teachers to reflect on and refine their instructional practices, and enable leaders to evaluate the effectiveness of their instructional management plan, Lavinia Group equips leaders with the structures needed to deliver strong and sustainable math instruction.

"The ability for math teachers to have the time to collaborate around intellectual preparation and look at data daily is critical, carving out the time and structure for them to do that work. Easy to say we have PLCs, but if [they're] not used correctly and valued, this work wouldn't have been able to happen."

Amy Cochran, Senior Officer of Academics and Innovation, Fridley School District, Minnesota

Create Structures to Support the Vision

Teachers require sustained, hands-on learning opportunities to consistently and effectively implement evidence-based practices. Lavinia Group's instructional coaching model is anchored in a Rapid Improvement Cycle, designed to help leaders and teachers transfer what they learn into classroom practice. The Rapid Improvement Cycle is characterized by pre-lesson teacher intellectual preparation, collaborative coaching and instructional modeling during class, and data analysis and teacher debriefs after class.

Intellectual Preparation. Lavinia Group partners learn to engage in collaborative intellectual preparation, which involves instructional planning focused on content mastery and grounded in student work and data analysis before the lesson.[98] By shifting teachers' focus to reviewing lesson goals and standards, identifying potential misconceptions and anticipated responses, and providing opportunities for lesson rehearsal, Lavinia Group aims to improve the rigor of teachers' intellectual preparation and subsequent instruction before they step into the classroom.

In-Classroom Modeling and Coaching. During their lessons, Lavinia Group coaches provide partners with collaborative and job-embedded coaching. The goal of instructional models and classroom coaching is to accelerate teachers' growth by providing real-time feedback, as it builds transferable teaching skills. While Lavinia Group begins its partnerships by modeling this shoulder-to-shoulder coaching, it also trains instructional coaches to ensure coaching is sustained.

Formative Data Analysis. Because effective coaching is rooted in data, Lavinia Group leads partners through post-lesson debriefs that center on student work and data study. Partners learn to use data to plan upcoming instruction, organize small groups, and reteach based on students' specific learning needs. Each Rapid Improvement Cycle concludes with action planning, where teachers study student data and goals to design responsive next steps. Together, these practices create a coherent support system that drives instructional growth and accelerates sustainable student learning.

"Teachers have always met and collaborated, but the subject-specific focus on intellectual preparation is where the change happened. … This past year, we focused on 'What is being taught?' 'How can we talk through misconceptions?' 'What is your data showing you about where your students are?' 'What is my data showing me?' They were having really specific conversations around student work data and thinking about planning their lessons together."

Amy Cochran, Senior Officer of Academics and Innovation, Fridley School District, Minnesota

A New York Bright Spot

A group of New York City charter schools partnered with Lavinia Group to receive instructional coaching and a supplemental math curriculum between 2016 and 2022. Their individual multiyear engagements (ranging from 36 to over 1,100 coaching days – depending on the school's specific commitment) included support for K-8 math teachers and, in some cases, the implementation of a supplemental "core math block" called Story Problems based on the Cognitively Guided Instruction approach to teaching math. After one year of receiving Lavinia Group support, schools experienced improvements in overall student math proficiency. On average, these gains were maintained by schools even after two years.

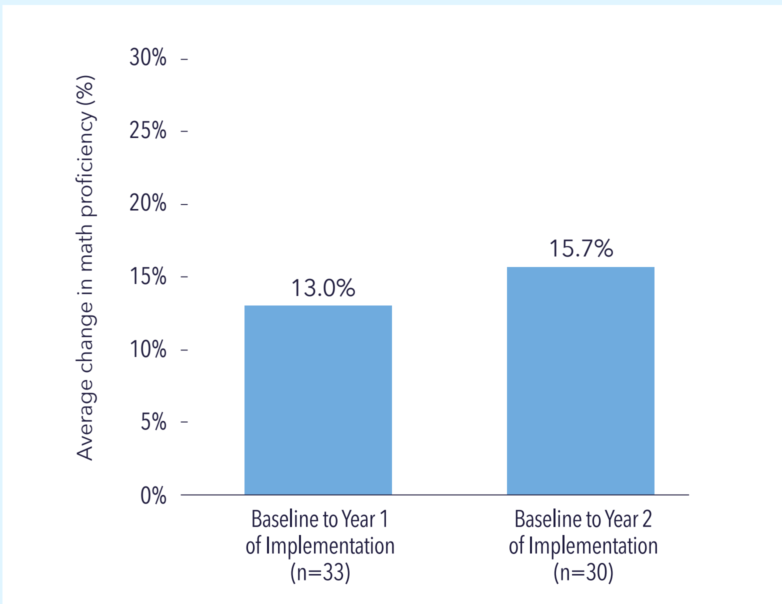
With High-Quality Instruction, Students Can Become Proficient in Math

"Intellectual preparation was one of the major components we focused on. I observed teachers getting stuck in this procedural mindset. So we began shifting toward the idea of identifying misconceptions students might have. If we anticipate students to have these misconceptions, then we can ask, what is a backup question or strategy they already know that can help them understand the concept better? So, the first step was understanding that it's not just about procedures like turn and talks or simple agree/disagree activities. To develop higher-level thinking, it all comes back to the teachers' intellectual preparation and the leaders creating space to guide that planning time."

Kaitlyn O'Connor, Principal,
Icahn Charter School 3, New York City

An analysis of school proficiency data shows that schools partnering with Lavinia Group saw significant improvements in math achievement. On average, these schools improved by 13 percentage points on the New York State math assessment after just one year of implementation (Figure 6). These improvements not only persisted but also slightly increased over time. One year after the program ended, schools still showed an average increase of 15.7 percentage points compared with their baseline proficiency scores.

Figure 6. Average Percent Change in K-8 Students' Math Proficiency Scores for New York City Schools Using Lavinia Group

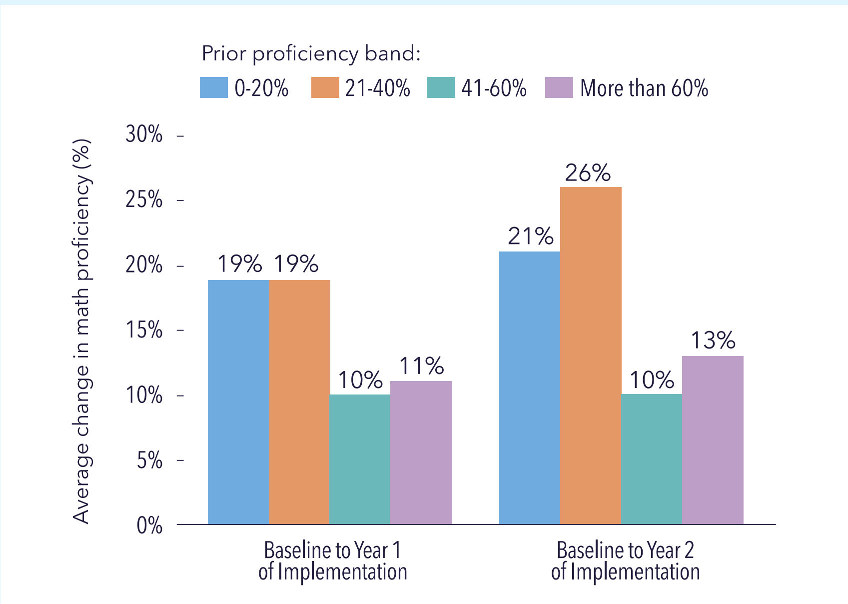


This analysis illustrates the weighted average change in schools' proficiency scores across their years of participation in the program. The differences were not assessed for statistical significance. See appendix for more details on the data and analysis methodology.

Effective Math Instruction Can Reach Students, Irrespective of Their Prior Performance

A key challenge in improving student achievement is ensuring that gains are shared across all proficiency bands. Data analysis shows that schools receiving Lavinia Group support made progress regardless of their starting point (Figure 7). After a year of professional development, schools with baseline proficiency rates below 20% improved by an average of 18.9 percentage points, while those beginning between 21% and 40% increased by 19.3 percentage points. Even schools at higher proficiency levels experienced significant growth, with gains of 9.8 percentage points among schools starting at 41% to 60% and 10.8 percentage points among those above 60%.

Figure 7. Average Percentage Point Change In Students' Math Proficiency Scores For New York City Schools Using Lavinia Group, By Schools' Prior Proficiency Band



This analysis illustrates the weighted average change in schools' proficiency scores, by prior proficiency. The differences were not assessed for statistical significance. See appendix for more details on the data and analysis methodology.

By Year 2 of implementation, schools with a baseline proficiency of 21%–40% saw the largest increase, improving by an average of 26 percentage points. However, higher-performing schools (41%–60% and above 60%) sustained their Year 1 gains, maintaining an average improvement of 10 percentage points.

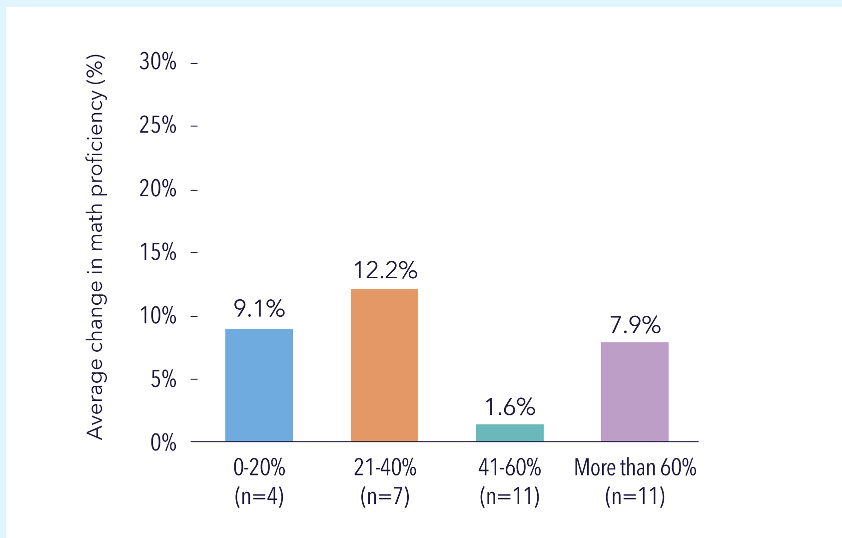
"[Lavinia Group support] has created a classroom culture where students know they can have a different approach to solving a problem, and that if it is incorrect, they can lean on a friend to help, and that becomes a little less risky. The risk is gone because they know other students will share strategies, and they can build on each other's thinking."

Kaitlyn O'Connor, Principal,
Icahn Charter School 3, New York City

High-Quality Math Instruction Boosts School Performance Compared With Peers'

After one year, schools receiving Lavinia Group support demonstrated greater growth on state math assessments compared with similarly performing New York City public school peers (Figure 8).[99] Schools that began with 21%–40% proficiency saw the largest relative gains, improving by an average of 12.2 percentage points more than their peers, while those starting at 0%–20% proficiency outpaced peers by an average of 9.1 percentage points. These findings suggest that schools applying the skills learned through this instructional coaching may outperform comparable schools that do not receive the support.

Figure 8. Average Percentage Point Difference Between Lavinia Schools and Their NYC Public School Peers After One Year of Implementation



These outcomes represent the average difference in student proficiency growth between Lavinia Group partner schools and their New York City peers one year after implementation. The differences were not assessed for statistical significance. See appendix for more details on the data and analysis methodology.

These results reveal the potential of high-quality, evidence-based math instruction to drive measurable improvements in student achievement, regardless of a school's starting point. As education leaders look for strategies to improve math outcomes, these schools demonstrate that pairing high-quality math materials with intentional, effective teaching practices and strong professional learning supports can significantly boost student proficiency.

Conclusion

Improving math outcomes and building an ecosystem that supports effective math instruction doesn't happen overnight. It requires commitment, coherence, and collaboration across all levels of the education system. As instructional leaders begin this journey, they must ensure that foundational structures are in place to anchor sustainable and equitable improvement. First, leaders should **establish a clear, shared vision** for what effective math teaching and learning looks like in classrooms, emphasizing the importance of math identity, conceptual understanding, and procedural fluency. The vision should also guide instructional decisions for all educators. Second, leaders must **create systems and resources aligned with that vision**. This can include auditing the current standards, curriculum, and assessments to identify gaps or misalignment. This ensures that what is taught, how it is assessed, and the standards to which it is aligned all reinforce the same instructional goals. Finally, leaders should **create structures that support that vision** by building cohesive professional learning systems. This includes ensuring professional development supports and collaboration structures are aligned with and reinforce the vision. Together, these actions lay the groundwork for a coherent, high-impact math instructional system that helps all students thrive.

About the Organizations

About Bellwether

Bellwether is a national nonprofit that exists to transform education to ensure that young people furthest from opportunity achieve outcomes that lead to fulfilling lives and flourishing communities. Founded in 2010, we work hand in hand with education leaders and organizations to accelerate their impact, inform and influence policy and program design, and share what we learn along the way. For more, visit **bellwether.org**.

About K12 Coalition

K12 Coalition is a leading education solution partner delivering products and services across the education spectrum. From teacher development to school improvement to curriculum, K12 Coalition provides solutions that dramatically improve learning outcomes and enable students to achieve their fullest potential.

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Appendix

Data & Methodology

To evaluate changes in math proficiency for Lavinia Group-participating schools, researchers compiled two main data sources: (1) publicly available New York City charter and public school math proficiency rates, reported annually at the school level, and (2) program start year information for each participating school provided by K12 Coalition. Math proficiency rates reflect the percentage of students scoring at or above the state's proficiency benchmark on annual standardized math assessments. Some schools were excluded from the analysis because state assessment data for 2020 and 2021 were unavailable.

Average Change From Baseline to Year 1 and Year 2 (Figure 6)

For each school, researchers recorded the percentage of students proficient in math in the baseline year, at the end of Year 1, and at the end of Year 2. They calculated the percentage point change for each school between baseline and Year 1, and between baseline and Year 2. They then computed a weighted average across all Lavinia Group schools, weighting by the number of students tested in each school's implementation year. These results were not tested for statistical significance.

Average Change by Prior Proficiency Group (Figure 7)

Using the same method, schools were grouped into four categories based on baseline math proficiency (percentage scoring proficient or above during the baseline year). Weighted averages for each group were calculated as above. These results were not tested for statistical significance.

Average Difference vs. Peer Schools (Figure 8)

Lavinia Group schools were first grouped into prior proficiency bands based on their baseline math proficiency. For each band and year, researchers calculated the weighted average proficiency of similarly performing New York City public schools (peers), weighting by the number of students tested. Next, they calculated the change in proficiency from baseline to Year 1 for each Lavinia Group-participating school and for its peer group. They then found the difference between those two changes, representing the relative growth of each Lavinia school compared with its peers. Finally, they calculated the weighted average of these differences within each proficiency band. These results were not tested for statistical significance.

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