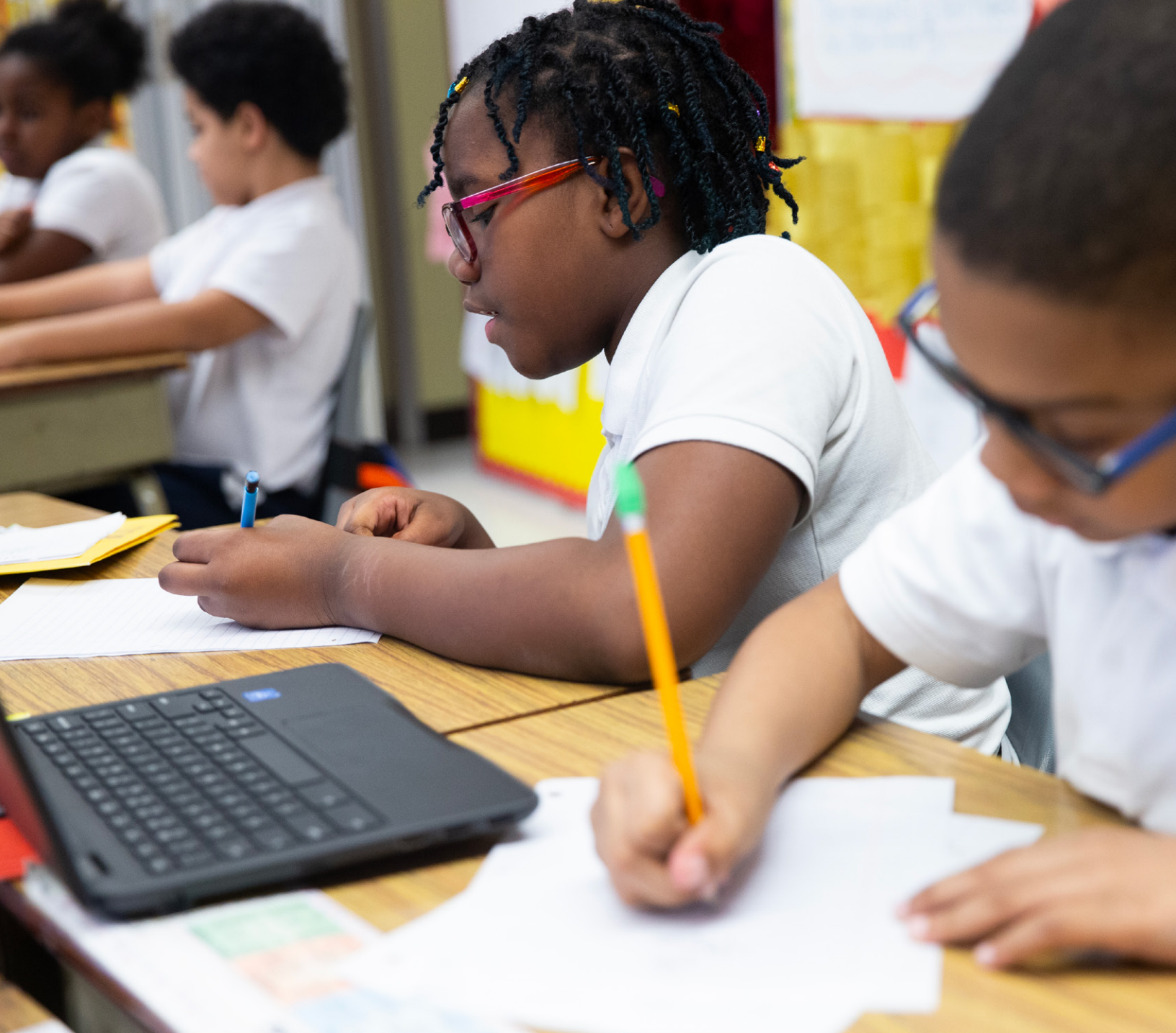




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# Table of contents

## **4**

Everything you ever wanted to know about early numeracy but didn't know to ask

## **10**

6 tips for supporting problem-based learning in your math classroom

## **16**

When are students “ready” for algebra?

## **20**

What does proficiency in mathematics look like?

## **27**

About the authors



Math is everywhere in the world around us, yet [many of us still feel anxiety, ineptitude, or both](#) when it comes to the subject. With this compilation of posts from our blog, [\*Teach. Learn. Grow.\*](#), we invite you to learn more about how to inspire a love of math in your classroom and help the next generation approach it with curiosity, confidence, and even excitement.



# Everything you ever wanted to know about early numeracy but didn't know to ask

## **Mary Resanovich**

Over the last few years there has been a buzz in education about literacy and [the science of reading](#). Within these conversations there has been a particular focus on early literacy and what research indicates are the best ways to teach children to read. According to a 2023 50-state comparison by the [Education Commission of the States](#), [nearly 40 states required interventions](#) for K–3 students who are reading below grade level, just over [25 states had a policy either allowing or requiring retention](#) at grade 3 for students not reading at grade level, and [45 states had policies about pre- or in-service literacy training](#) for K–3 educators. Interestingly, there are far fewer policies or requirements for early numeracy, [although the number is slowly starting to grow](#). Currently about 15 states are considering or have enacted bills related to early numeracy screening, although there is some discrepancy around what is meant by “early” and what skills should be measured.

Even with this growing focus, a good deal of the discussion around math education is focused more on the other end of the system: pathways for success in college mathematics. The disparity in interest in early literacy

and early numeracy can be illustrated via the simple and highly unscientific process of searching both terms online. On a recent day, the search term “early numeracy” produced 10,600,000 results, or about 1/15 of the 148,000,000 results produced by the search term “early literacy.” The term “math pathways” produced 201,000,000 results, far closer in magnitude to the “early literacy” results, indicating that the field is still more concerned with math in the later school years than in the earlier years.

Make no mistake. My goal here is not to discourage interest in either early literacy or high school math pathways. Rather, I want to make a case for why early numeracy should generate the same level of interest as these other topics.

## What’s the big deal?

There are many reasons to focus on early numeracy. A key one, and a possibly less well-known one, is the power of early math understanding to predict long-term student outcomes, and not just in math.

[Several studies](#) have found that early math skills are good predictors of later reading achievement. One [meta-analysis of six longitudinal data sets](#) found that skills like number knowledge and ordinality have twice the effect size—0.34 vs 0.17—in predicting later reading achievement than do measures of early reading skills. [Another study](#) found that kindergarten math skills may be predictors not only of later reading achievement but potentially of later social-emotional behaviors, including physical aggression and improved attention.

In terms of predicting future math achievement, a [study conducted by researchers at the University of California, Carnegie Mellon University, and the University of Michigan](#) found that preschool math knowledge may predict math achievement through age 15. They also found that the growth made in math in kindergarten and first grade is even more predictive of later achievement. This finding and those from [other studies](#) suggest that early intervention in mathematics may be critical for improving students’ long-term achievement in math. Without targeted, purposeful intervention, the [research](#) seems to suggest that where a student starts in math sets the trajectory for where they wind up.

## Ensuring the right focus

So, now that the importance of early math is clear, what concepts and skills should teachers focus on in the early grades? Thankfully, research can provide some direction here as well. [Several studies](#) point to the [importance](#) of supporting students' [number sense](#). A [2009 publication by the National Academies](#) and a [2021 study](#) both highlight three critical subdomains of early numeracy: number, number relations, and number operations.

- **Number** refers to students' understanding of whole numbers, including counting, cardinality (understanding that the last number word said is the number of objects counted), subitizing (quickly determining the number of items in a set without counting), number recognition, and counting on and, eventually, counting by numbers other than one.
- **Number relations**, which includes understanding number magnitude, comparing and ordering numbers, and representing numbers on a number line.
- **Number operations**, which refers to composing and decomposing numbers. This lays the foundation for addition and subtraction.

In the book [Mathematics Learning in Early Childhood: Paths Towards Excellence and Equity](#), the National Academies concludes that in addition to these early numeracy topics, the topics of geometry and measurement are also important to focus on in early mathematics. These topics are highly connected to [spatial reasoning](#), which [research](#) has shown supports performance in other mathematical domains. One [study](#) highlighted how development of spatial reasoning can support early numeracy by improving students' understanding of number lines and number magnitude. Both *Mathematics Learning in Early Childhood* and [What Works Clearinghouse's Teaching Math to Young Children](#) provide insight into the progressions of skills in early numeracy, geometry, spatial reasoning, and measurement as well as suggested activities and teaching approaches.

## Building on what students know

Finding a curriculum that adequately supports the development of early numeracy is a key first step. It is also important to determine what knowledge students enter school with. Children have an [innate number sense](#) that develops before they ever [enter a classroom](#). Given the wide variety of experiences students have before starting school, they will naturally enter with different levels of mathematical understanding. Assessing what students know upon school entry and exposing them to appropriately advanced content is critical.

The [2021 study discussed earlier](#) suggests that for students who enter school with lower achievement in math, supporting development of number and number relations may be more impactful for future math achievement. For those who enter with more understanding of number, counting, and cardinality, focusing on number operations seems to support later high achievement. A [2013 study](#) that found similar results also highlighted the mismatch between students' ability and what is often taught in early math classes. The study found that kindergarten teachers spent the majority of their time in math on basic counting and shapes despite more than 95% of students showing mastery of these skills upon entry.

When assessing where students are in their understanding of math, it is important to consider biases that have resulted in historically marginalized children being [denied](#) rich, engaging, and challenging mathematics lessons and activities. In their book [High Stakes: Testing for Tracking, Promotion, and Graduation](#), editors Jay Heubert and Robert Hauser argue that “minority students and low-SES [socioeconomic status] students are proportionately overrepresented in classes typically characterized



by an exclusive focus on basic skills, low expectations, and less qualified teachers.” While students who enter with lower achievement may benefit from a stronger initial focus on number and number relations, these concepts should be taught rigorously and with high-quality materials and activities and with the goal of getting all students access to more challenging content. The knowledge students have upon entering school should be viewed as an asset upon which to build, not a deficit used to lower expectations and remove opportunities.

## Developing a lifelong love of math

Although there has been much talk about the prevalence of math anxiety, most of this has focused on students in later elementary school and beyond. Unfortunately, there is evidence that [math anxiety can start early](#) and that it can have a [long-term impact on achievement](#).

In the short term, math anxiety can overload working memory and affect learning. Long-term, math anxiety may cause students to self-limit in terms of the types of math classes they take. [NCTM's position statement on mathematics in early childhood learning](#) captures both the impact and opportunity that early math experiences hold for children: “Early childhood is an important and vulnerable time; these years lay the foundation for a child’s mathematical journey. High-quality early mathematics experiences have a long-lasting impact, serving as a catalyst for children’s later success in life. These beginning exposures to mathematics send powerful messages about who and what is valued.”

NCTM’s position statement and their joint position paper with NAEYC, “[Early Childhood Mathematics: Promoting Good Beginnings](#),” both describe ways to support early numeracy and a love of mathematics right from the start. At the center is the need to provide equitable access to content, experiences, and settings that leverage children’s natural curiosity and innate number sense and that also celebrate and build upon their diverse backgrounds, languages, and experiences. Children come to us with experience using math in their everyday lives. Our job as teachers is to build upon this by providing children with interesting and appropriately challenging activities that further the connection between math and the world around them.

## Looking for more?

Here are some great resources for more information on supporting young students as they develop early numeracy:

- [Early childhood math videos](#): The Institute of Education Sciences/ Regional Educational Laboratory Program has created videos focusing on developing both key early math skills and effective questioning strategies.
- [Early literacy and early numeracy](#): Experts Cindy Jiban and Tammy Baumann discuss early literacy and early numeracy on NWEA's [The Continuing Educator](#) podcast.
- [Early Math Counts](#): This site created by the University of Illinois Chicago College of Education contains a wealth of resources including preschool math lessons; access to free, online professional learning; and videos about teaching different math topics and creating a math-rich environment in your classroom.
- [Early math resources](#): This site, developed by Stanford University's Development and Research in Early Mathematics Education project, houses early math resources for families, teachers, and teacher educators.
- [Education Week early math](#): This is a repository of all of Education Week's current and past articles related to early mathematics.
- [NAEYC](#): The National Association for the Education of Young Children's math site contains articles for educators and families about how children learn math and playful ways to engage in math at school.
- [Todos: Mathematics for ALL](#): This site contains English and Spanish publications and resources for both families and educators designed to support equity and high-quality math education for all students. **TLG**



# 6 tips for supporting problem-based learning in your math classroom

**Kailey Rhodes & Kristen Tsutsui**

More and more, math teachers are being called upon to “make the learning relevant” and provide real-world context and problem-based learning. This raises some questions: Pragmatically, is math irrelevant? More esoterically, what is “real”? And, most famously, “When will we need to know this?”

Most math teachers have been here before. We’ve all transposed the names of our own students for those in a word problem. We’ve all used our school community goings-on as fodder for plot lines: “If 89 middle schoolers are traveling on buses to Outdoor School, and each bus can transport 35 students and four chaperones....” But how “real world” are we really getting?

We—Kailey Rhodes and Kristen Tsutsui, math teachers and authors of this article—wanted to know teachers’ experience with real-world problem-solving, what’s going well, and what’s in their way. So we surveyed some. In this article, we’ll walk you through what we asked, learned, and think as we move forward—and we’ll also share the resources our teachers shared with us. But first, let us introduce you to an official definition of real-world context in the math classroom.

## The PISA Mathematics Framework

[PISA](#) is an international assessment administered to 15-year-olds globally. In their *2022 Mathematics Framework*, PISA explains the underpinnings of their assessment as it relates to math literacy, reasoning, and problem-solving. It also stipulates that to uplift these underpinnings, mathematics problems should be presented in real-world contexts: personal, occupational, societal, and scientific.

Educators, take a moment to read [the descriptions of these contexts](#). As you read, ask yourself the question we asked in our survey: “Which do you naturally find yourself gravitating toward in your classroom?”

- **Personal:** “Problems classified in the personal context category focus on activities of one’s self, one’s family, or one’s peer group. Personal contexts include (but are not limited to) those involving food preparation, shopping, games, personal health, personal transportation, sports, travel, personal scheduling, and personal finance.”
- **Occupational:** “Problems classified in the occupational context category are centered on the world of work. Items categorized as occupational may involve (but are not limited to) such things as measuring, costing, and ordering materials for building, payroll/accounting, quality control, scheduling/inventory, design/architecture, and job-related decision-making. Occupational contexts may relate to any level of the workforce, from unskilled work to the highest levels of professional work, although items in the PISA survey must be accessible to 15-year-old students.”
- **Societal:** “Problems classified in the societal context category focus on one’s community (whether local, national, or global). They may involve (but are not limited to) such things as voting systems, public transport, government, public policies, demographics, advertising, national statistics, and economics. Although individuals are involved in all of these things in a personal way, in the societal context category, the focus of problems is on the community perspective.”
- **Scientific:** “Problems classified in the scientific category relate to the application of mathematics to the natural world and issues and topics related to science and technology. Particular contexts might include (but are not limited to) such areas as weather or climate, ecology, medicine, space science, genetics, measurement, and the world of mathematics itself. Items that are intra-mathematical, where all the elements involved belong in the world of mathematics, fall within the scientific context.”

Which context did you most resonate with? If you were to focus on one context per quarter, how would you order them? What is your biggest struggle with real-world context and problem-based learning? How do you bring the “real world” inside your classroom?

We surveyed a focus group of math teachers, from kindergarten to IB, to see what they thought.

## Survey says!

When we asked our teachers, “Which do you naturally find yourself gravitating toward in your classroom?” personal and scientific contexts were the winners, with societal coming in fourth. Our guess for this is that societal is not only ever-changing but is also often politically adjacent, something educators can, understandably, be wary of approaching.

Naturally, personal real-world math context offers an entry point into students’ interests, which is paramount in the math classroom. One teacher said, “Good projects that connect to the curriculum and also interest the students are worth their weight in gold. I really wish publishers did a better job of planning good projects; in most books I’ve used, the projects, if they exist at all, are an afterthought and poorly done.”

When it comes to other contexts, like societal, the bullseye of curriculum connection, student interest level, and math teacher time is a hard one to hit. As one teacher said, “With more time I would like to start new math topics with ‘real world problems’ and have the students brainstorm what knowledge would be useful to solve them, building resilience in the face of complex problems. However, these kinds of freeform explorations take time that I often feel like I don’t have in my class.”

This theme of “not enough time” appeared often, with teachers expressing a desire for more real-world presence, including cross-collaboration with other colleagues. A teacher said, “I have tried to coordinate with science classes to talk about the mathematical aspects of science concepts they are learning, but it can be hard to coordinate and map those kinds of things onto my own curriculum.”

This was echoed in the teachers’ comments, along with many wishful statements about what they “would do...if.”

## With all the time and resources, what would teachers do?

We asked teachers to describe their dream scenario: what they would do if they had more resources, time, and permission. In most responses, what stood out was teachers' love for math's interconnectedness and innate curiosity. Some dreamed big:

- “An interdisciplinary project across all subjects that would allow students to see how math applies to all facets of the world”
- “Something like ‘a history of mathematical thought,’ bringing history, culture, psychology, ecology, science, and engineering into the curriculum”
- “Students being given the opportunity to explore a problem they are passionate about and explore ways that mathematics can be used to help solve it”
- “Students working alongside professionals in various math-related fields so they can see, firsthand, how the math they are learning is currently being used”

It's clear that teachers want to provide classroom experiences that both underscore math's omnipresence in the world around us and ignite students' interests. It's also clear that when your survey takers have to type qualifiers like, “But this would take a lot of time” and “We don't have the resources for this,” the “real world” is actually what's in the way. So, what can be done?

## From ideal to real: Helpful tips & a relaxing thought on problem-based learning

No one knows better than math teachers that you can't add time to your school day. But, through our interactions with teachers, we walked away with some resources and tips to share with you. Here are the gems:

1. **Split it into quadrants.** Most teachers surveyed would order their quarters and contexts like this: first quarter, personal; second quarter, societal; third quarter, scientific; fourth quarter, occupational.
2. **Switch with science.** One teacher said this: “Actually switch classes with a science teacher to reiterate how what they are learning in science is related to what we do in math. And then they can come to my class to do the same so they can really understand the connection.”

- 3. Draw a parallel.** “Have a project that seems like it might belong in an arts classroom, like creating a piece of clothing,” another teacher suggested. “They have to use multiple modes of mathematical knowledge to do this, like unit conversions (centimeters to inches to yards), spatial constraints (if fabric is a certain size, can I fit my pattern in it? How big do the pieces have to be to fit on the body?), and area (how much fabric do I need?).”
- 4. Estimate.** “I use [Estimation 180](#), but I gamify it to address average, mean, median, and mode. I have students secretly record their estimations, and I write them all on the board. We discuss the average classroom guess and how close our range is. Estimation is everywhere.”
- 5. Level up.** “I’ve been using [Skew the Script](#) to heighten engagement for all my students and teach them about larger global issues affecting society. Their [After The AP Data Science Challenge](#) aims to solve the real (unsolved) problem of finding a model to predict the best and worst colleges for conquering student debt.”
- 6. Build the roster:** “Try to arrange a handful of yearly speakers and field trips you can count on to bring the math to life. My husband is a civil engineer and uses the Pythagorean theorem. You’d be surprised how many folks would love to come in and talk to a math class—with your teacher guidance and enthusiasm, of course.”



And now for the relaxing thought: Start small. As with any endeavor in the classroom, no matter the discipline, the key is to work incrementally. We already know how important increments are, right, math teachers?

## What is “real,” anyway?

Let’s return to the age-old question of, “When will we ever use this?” It plagues math teachers perhaps more than any other discipline, and the task of “real-world” problem-solving often feels like a “gotcha” moment. The fact is, sometimes, we math teachers don’t have a great real-world example of dividing negative fractions in our back pocket. But does that mean that it isn’t worth learning? Must every concept in math be nested perfectly within the “real” world?

In one particular mic-drop moment, one of our teachers shared, “I think the label ‘real-world’ has been used extensively in math education, and I’ve found it a bit frustrating. In many regards, math is the least ‘real’ discipline we teach children. It is, largely, the art of abstraction! That it is ‘real’ is in many ways the least interesting and important thing about it as a system of thinking, and this is often lost when continually looked at with the question ‘When will we ever use this?’”

Maybe when we’ll “use this” is when we’re thinking through a problem with many facets and variables. Math is, after all, less of a “what” and more of a “how.” How should we go about solving this? How do we use computational thinking to solve problems? How do we spiral what we already know with what we don’t?

We’re teaching kids *how to think*—and isn’t that the most real-world skill we can possibly teach? **TLG**



# When are students “ready” for algebra?

**Scott Peters**

It will not come as a surprise to any educator that students are diverse in what they know and can do. Take any classroom of 30 students and it will include those who have had dramatically different life experiences. It will also include students who are at very different levels in their math content mastery: what concepts they’ve already learned and what mathematical procedures they can apply.

A few years ago, Blaine Pedersen, now a psychometrician at NWEA®, [analyzed data](#) from the [Trends in International Mathematics and Science Study \(TIMSS\)](#) to see how many of the four international benchmark proficiency levels were present in an average American eighth-grade classroom. These benchmarks span the continuum of students who do not yet have basic knowledge of whole numbers and graphs up through those who can solve linear equations, understand linear functions and algebraic expressions, and interpret a wide variety of data to draw inferences. What percentage of American classrooms include students at all four of these levels? 35%. That’s right: one in three American eighth-grade classrooms includes both students who need help understanding whole numbers and students who are already algebra proficient. Prior research using [MAP® Growth™](#) data has generated similar findings. In a study of two large districts, we observed that the range of student math readiness in a typical classroom spanned three to seven grade levels.

Challenging all these students and helping them grow is a difficult task for even the most seasoned educator. While much of the focus, both historically and post-pandemic, has been on how to best help learners

who would benefit from extra support, this work calls out the fact that many classrooms also include students who are ready to move on to more advanced content. Many of the eighth-grade TIMSS classrooms mentioned above included students who were already proficient in algebra. Many more would be ready to learn algebra in eighth grade, even if they are not already proficient ([perhaps as many as 40%, according to one study](#)). And students who complete Algebra 1 by eighth grade (as opposed to ninth) often benefit by going on to take [more—and more advanced—math courses](#). But [placing students in Algebra 1 before they are ready can have negative consequences on their achievement](#). So how are schools to know when students are ready and would benefit from enrolling in Algebra 1? This is the topic of [guidance released by NWEA](#) in 2024.

## New guidance on using MAP Growth for Algebra 1 placement decisions

To answer this question, we first had to define what “success” in an Algebra 1 course looks like. While by no means an exhaustive or definitive list, we settled on two definitions to guide parallel analyses. In one analysis, we defined success as a score of “proficient” or “meeting standards” on a state end-of-course (EoC) exam in Algebra 1. These tests, given in states such as Ohio, Texas, and Georgia, are administered to students at the end of an Algebra 1 course as a kind of summative accountability exam specific to algebra standards. For the second analysis, we partnered with three NWEA school districts to collect data on Algebra 1 course grades. Although each district handled grading differently, in each case, we identified a grade above which we coded students as “proficient” or “successful” in Algebra 1.

With both benchmarks of success in hand, we were able to work backward to identify the MAP Growth 6+ math score a student needed to have earned the prior spring, that is, in the spring of seventh grade, to have a greater than 50% chance of scoring proficient on an EoC exam or in a course grade. While the exact score was slightly different depending on the metric of success (we discuss this more in [the guidance document](#)), even we were surprised by the consistency. Students needed to score around a 235 to 238 on MAP Growth in the spring of seventh grade to be on track to score proficient at the end of an Algebra 1 course. According to [NWEA norms](#), this is roughly one-third of students in the spring of seventh grade, or roughly one-fifth of students in the spring of sixth grade.

## Unpacking the guidance

Of course, there is nuance to this seemingly simple answer.

First, it’s important to emphasize the relatively low or inclusive cut score we used for our analyses. By looking for students who have a greater than 50% chance of being successful, in an average school, up to 50% of students who are placed in Algebra 1 will go on to not be successful in the course. Some schools might be uncomfortable with this and want to set a higher probability for success. And that’s fine! Our guidance describes how partners could adjust their placement criteria accordingly. But higher cut scores also mean some students who *would* have gone on to do well will be missed. This is why districts should think carefully about how to balance these competing priorities.

Second, especially regarding EoC exams, these recommendations are based on average growth over the course of eighth grade. Some students will grow more than average, and some will grow less. Schools can review historical growth for their own students and modify placement criteria accordingly. If students tend to grow at atypically high levels, students can be placed with lower scores. Conversely, if students tend to require extra supports, the decision might be made to only place students with higher scores (ideally also using other data points to make such a decision). Again, schools need to balance inclusiveness (i.e., lower cut scores for placement) with the instructional implications of needing to provide additional supports to students who might have gaps in their pre-algebra knowledge.



Third, our analyses assume a certain amount of instruction, that is, [28 weeks between fall and spring testing](#). Schools that have 32 weeks between testing events could admit students with lower scores because their students have more time to learn the content before any EoC testing or final grading.

And finally, while we believe MAP Growth can help schools make decisions about Algebra 1 placement, such decisions are always best made with multiple data points and from a strengths-based perspective. Some students will score lower than the benchmarks we’ve identified and will do very well in an algebra course. MAP Growth can help with that decision, but only educators have the complete picture.

## Why does it matter?

The NWEA mission is partnering to help all kids learn®. We see the new guidance as directly contributing to this mission by helping schools identify students who would learn best in an Algebra 1 course. The identification process has important equity implications. Absent a universal and proactive screener for which students might be ready for such a course, the default is often relying on parent requests or teacher referrals. The result ends up being differences in enrollment by race or gender that [cannot be explained by differences in test scores](#). An effective and equitable placement system will flag all students who are ready and would benefit, regardless of their race, ethnicity, gender, socioeconomic status, or zip code. **TLG**



# What does proficiency in mathematics look like?

**Aaron Kugler**

Education leaders, politicians, researchers, and teachers have been attempting to define proficiency in mathematics for years. Within the current educational system, the most popular measure of a student's ability in the discipline of mathematics boils down to a single score on a single test administered once a year. That is not enough.

## The current landscape

Though [standardized testing has been a part of education for many years](#), No Child Left Behind really made the push to reduce student achievement to a single cut score and label students as “below,” “approaching,” “on-level,” or “above.” This has had a [ripple effect on nearly every aspect of education](#), from the perceptions of the student and their opportunities to teacher evaluations and district-level funding.

But the impacts go beyond that to define not only what math should be taught but how it should be delivered. High-stakes assessments place an [overemphasis on product over process and memory over cognition](#). To meet the demands of the standardized tests, [narrowed learning progressions are designed](#) to teach content as quickly as possible so

students have a fair run at the test each year. This reduces mathematics to a rigid timeline of skills and shortcuts, rather than a rich landscape of concepts that develop and connect to each other organically.

Because most classrooms are forced to rush down the prescribed track, computational speed and accuracy become the primary measure of a student's success—and are often mistakenly equated with proficiency. All this rushing to perform also keeps teachers from opportunities to make genuine connections to the big ideas, transition naturally between concepts, or teach flexibly without regard to the traditional sequence.

## An alternate model for assessing proficiency

Standardized testing isn't going away, so the best place to start the search for a better approach is with redefining what it means to be proficient. What if the true measure of a student's proficiency in mathematics was more natural, authentic, and comprehensive?

In [\*Adding It Up: Helping Children Learn Mathematics\*](#), Jeremy Kilpatrick, Jane Swafford, and Bradford Findell propose a five-strand measure of successful learning in mathematics. The five interdependent strands of proficiency are:

- **Conceptual understanding:** The ability to comprehend the ideas and relationships behind the procedures
- **Procedural fluency:** The ability to carry out math procedures accurately, efficiently, and flexibly
- **Strategic competence:** The ability to solve unfamiliar problems by choosing the right strategies and tools
- **Adaptive reasoning:** The ability to think logically, justify a solution or approach, and reason through presented information
- **Productive disposition:** The ability to see math as useful and see oneself as capable of doing mathematics

How much more powerfully could a student's achievement in mathematics be described using these five strands? Imagine what a teacher could do with such nuanced understandings about a student, as opposed to what they can do with a single percentage of multiple-choice questions answered correctly. Breaking a student's math journey into five categories allows for richer feedback on strengths and areas of growth.

## Student examples

Consider a student who has been labeled “above grade level” in math on the past three years of standardized assessments. Perhaps this student is truly accurate and efficient in their calculations with all four operations (that is, procedural fluency) but sometimes has difficulty with transferring a concept to another unfamiliar context (adaptive reasoning) or understanding why the procedure they have memorized and can quickly reproduce actually works (conceptual understanding). This is, in fact, the story of many “advanced” students in elementary school. Though computationally fluent, many have difficulty explaining their reasoning, connecting ideas, or representing thinking in multiple ways, all skills not measured by standardized tests. Without multiple measures of proficiency, this oversimplified view of “above grade level” stunts the student’s opportunities to grow in other areas and gives parents and even peers a false sense of what success in mathematics looks like.

Now consider a student who has been labeled “below grade level” for the past three years. Since intervention opportunities have been provided based on this test result, the student has spent significantly more time than the “above grade level” student on building concrete and pictorial models to develop their understanding of how the math works. This has resulted in a stronger ability to choose the right strategy and tool for a situation (strategic competence). But if we rely solely on a test focused on procedural fluency, this student’s growth in other areas—and eventual gains in fluency—may go unnoticed.

We are doing a disservice to both of these students when we expect a single measure of their ability to dictate their entire capacity for finding success in the discipline. Therefore, our mindset about how to assess students and report on these aspects of proficiency in mathematics needs to change.



## Sample tasks for assessing the five strands

High quality assessment consists of [providing a balance](#) of formal and informal opportunities to show understanding. Rather than retrofitting one of the strands into an already existing assessment, I encourage you to design new assessment tasks that target a specific strand.

Below are a few sample strong tasks that can measure proficiency or growth, depending on the assessment's purpose and timing. In presenting and categorizing the tasks in the ways I have, I also hope to illuminate some defining traits of strong assessment practices:

- **There is no single, expected path** to solve any of these problems.
- **No task is designed with a “quick” answer as the measure of proficiency;** in some tasks, there isn't even a single correct answer. In all cases, the student's line of thinking, their approaches to the problem, their representations of the problem, their strategies chosen, and the justification of their answer are all more powerful measures of proficiency than the correct answer.
- **All tasks touch on a concept familiar to students but likely present a context or situation that may be unfamiliar or new.** Encouraging students to show their abilities in a novel scenario highlights their ability to apply mathematics to a variety of situations, which is an underlying goal for each strand as well.

For more great assessment task ideas, try out [Open Middle problems](#), our free [Formative Conversation Starters](#), or even [student discourse as formative assessment](#).

### Conceptual understanding

Task: Given the number  $\frac{3}{8}$  on the open number line as shown, locate the number  $\frac{4}{3}$ .



This task assesses a student's ability to use spatial reasoning to accurately place a number on the number line relative to another. Students must understand the relationship between  $\frac{3}{8}$  and 1 whole (both conceptually and visually) before they can use the relationship between 1 and  $\frac{4}{3}$  to plot that point. Student performance on this task will reveal misunderstandings or validate student capability in grappling with the concepts of magnitude and division of a whole into equal parts.

## Procedural fluency

Task: Place the numbers 0–9 exactly once into the spaces in the expressions below such that each expression has a value of 32.

$$\begin{array}{c} (\_\_ + \_\_) \times \_\_ \\ \_\_ \times (\_\_ + \_\_) - \_\_ \\ (\_\_ + \_\_) \times \_\_ \end{array}$$

This task assesses a student's ability to efficiently and accurately evaluate expressions step-by-step using the order of operations in a creative way. While many traditional assessment items can measure a student's ability to follow a procedure and compute an answer accurately, creating a more rigorous task such as this reveals more about how the student applies known processes or approaches to an unfamiliar situation. How the student begins this task can be just as telling, if not more, than their ability to create three accurate expressions.

## Strategic competence

Task: A class is building a rectangular garden. They only have 72 feet of fencing to go around the garden. What dimensions of the garden would guarantee the most area for planting?

This task assesses a student's ability to formulate, represent, and solve a mathematical problem. No matter the solving strategy, the student should be encouraged to model the relationship in some way and rely on geometric and algebraic reasoning to come to an authentic conclusion.

## Adaptive reasoning

Task: A woman runs two races of equal length. In the second race, she finishes in 80% of the time it took her in the first. Does this mean she ran 20% faster? Explain.

This task assesses a student's ability to analyze a proportional relationship and deeply consider the actual difference between a 20% reduction in time and a 20% increase in speed, though these are sometimes incorrectly interpreted as the same thing.

## Productive disposition

Task: Design a math game for younger students that helps them learn about multiplication. What kind of game would you create? What is most important in the experience younger students have with your game and why?

This task assesses a student's ability to think creatively about what aspects of mathematics would be important to convey to younger students. They will, in turn, project their own values in learning mathematics and show confidence in their own ability to learn and use math.

## When to apply the data from five-strand assessments

Though I've spent a considerable number of words criticizing the improper application of standardized test results in this article, I believe they are still a viable metric as long as they are a) applied to a holistic understanding of the student in the right ways and b) used as one of many data points that tell a more comprehensive story of a student's learning trajectory. In fact, this is how we recommend schools testing with [MAP Growth](#) use the assessment's data.

Collecting data year-round from multiple perspectives strengthens teaching and aligns understanding among teachers, parents and other caregivers, and students. Here are some great times to apply the data.

### When planning instruction

Knowing specifically what to reinforce and build from with each student is a powerful tool. Labeling students as "below" or "above" or "good at fifth-grade math" doesn't inform how to push them to develop multiple dimensions of proficiency.

For more ideas on how to use MAP Growth and other assessment data when planning instruction, visit our [archive of posts on using assessment data](#) here on *Teach. Learn. Grow.*

### When making decisions about student grouping

Groups based solely on a single assessment score won't be as effective as those established from [purposefully grouping students](#) based on their strengths. Basing groups on multiple perspectives increases flexibility of grouping, ensuring that groups don't inadvertently become ability tracks. For example, perhaps you want to group together your strongest "conceptual understanding" students to make a short presentation for the rest of the class connecting your current unit to content they've already learned. Or perhaps you decide to mix the groups so everyone in the class

can benefit from having someone nearby who can explain the big idea behind the content you are currently exploring.

### **When communicating with parents and guardians**

A student's achievement in each of the five strands is great information for parents and other caregivers to have and can help structure conferences or answer the age-old question "What can we work on with them at home?"

### **During student self-assessments**

Five-strand data isn't powerful for just you or family members; let every student in on your insights, too. For example, if you are about to enter a division unit and a student knows they could use more practice representing their thinking, encourage them to self-advocate for more opportunities to practice with concrete and pictorial models. Additionally, students who may not be proficient based on a standardized test measurement can better see and define their strengths and possibilities for growth.

### **When framing the "above grade level" conversation**

Having more data to support a decision to put a student on an advanced math track never hurts. But being able to clearly show parents and other caregivers where there are still areas of growth for a student is vital. [Being computationally "fast" in math class](#) isn't the same as being 100% ready to tackle higher-level mathematics.

## **The ultimate goal**

We, as members of the current educational system, should put forth a concerted effort to create a new multi-dimensional model of proficiency in mathematics. A single data point can't define one's achievement in mathematics. By expanding to five strands of measuring success, we commit to redefining what being "good at math" looks like and can find more opportunities to let all students show their mathematical prowess. **TLG**

# About the authors



## **Aaron Kugler**

Aaron Kugler joined NWEA as a lead assessment designer in 2025, connecting MAP Growth assessments and data to other great resources for teachers. He has a passion for writing about mathematics, science, and best practices in instruction and assessment. Aaron has experience in educational publishing and has taught both elementary and middle school classrooms including gifted and talented and English language learners.



## **Scott Peters**

Scott J. Peters, senior research scientist at NWEA, specializes in educational assessment and data use, gifted and talented student identification, equity within advanced educational opportunities, and effectiveness of educational policy. He received his PhD from Purdue University in educational psychology and applied research methodology.



## **Mary Resanovich**

Mary Resanovich is a content design and development lead who has been with NWEA since 2011, working on both item development and test design. Her current focus is helping educators use MAP Growth data to make instructional decisions through our curriculum partnerships and ensuring the appropriate use of assessment data to support teachers and students. In addition to working at NWEA, Mary has 10 years of experience in educational publishing and was both an elementary education teacher and a K-5 gifted and talented specialist.



## **Kailey Rhodes**

With a background in middle school teaching, Kailey Rhodes is passionate about educational solutions that keep students at the forefront of their learning experience. She has taken this passion beyond the classroom, authoring and piloting curricula and leading webinars on education technology and pedagogical hotspots including curriculum development, e-sports in K-12, and how to (really) teach grammar. Her work in the classroom has included sixth-grade mathematics at Northwest Academy in Portland, Oregon, a school where students spend just as much time in academic subjects as in arts classes.



## **Kristen Tsutsui**

Kristen Tsutsui is a professional learning consultant for NWEA, where she facilitates enriching learning experiences tailored for K-12 educators focused on leveraging MAP Growth data to improve student academic outcomes. Prior to this role, she served as a content designer for NWEA's Responsive Math Practices suite, designing professional learning offerings aimed at deepening teachers' mathematical content and pedagogical knowledge and providing evidence-based guidance on effective math instruction. Kristen grew passionate about education during her six years serving as a middle school mathematics teacher in New York, New York, and Austin, Texas. During these experiences working with students in historically underserved communities, Kristen grew passionate about pushing and supporting all students' potential and confidence in math achievement.

Read more at

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