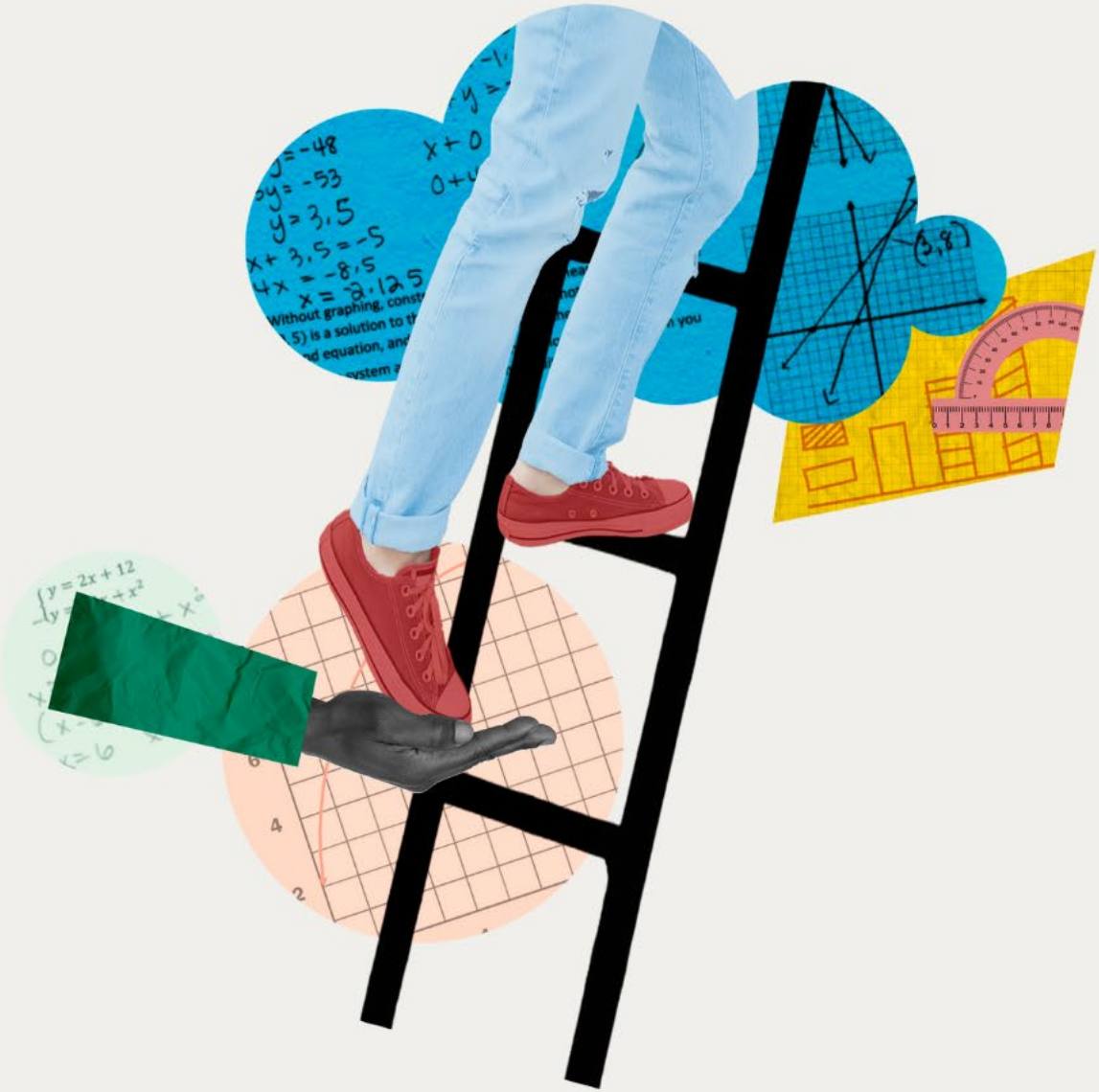
Unlocking Algebra

What the Data Tells Us About Helping Students Catch Up



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NEW CLASSROOMS

Dr. Mahnaz Charania

Chief Transformation Officer,
TNTP

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Our Agenda

- Setting the Stage
- Introduction: **New Classrooms**
- Research: **Unlocking Algebra Publication**
- Action & Next Steps

Joel Rose

Co-founder and Chief Executive Officer, New Classrooms

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Adam Maier

Partner, Research Center of Excellence, TNTP

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THE CHALLENGE

Today, as a nation, we are facing a crisis of opportunity.

Mobility is declining.

Income mobility has been on a steady decline since the 1940s.

Jobs are changing.

AI and technology are changing the job landscape. Around 8 million jobs sit unfilled.

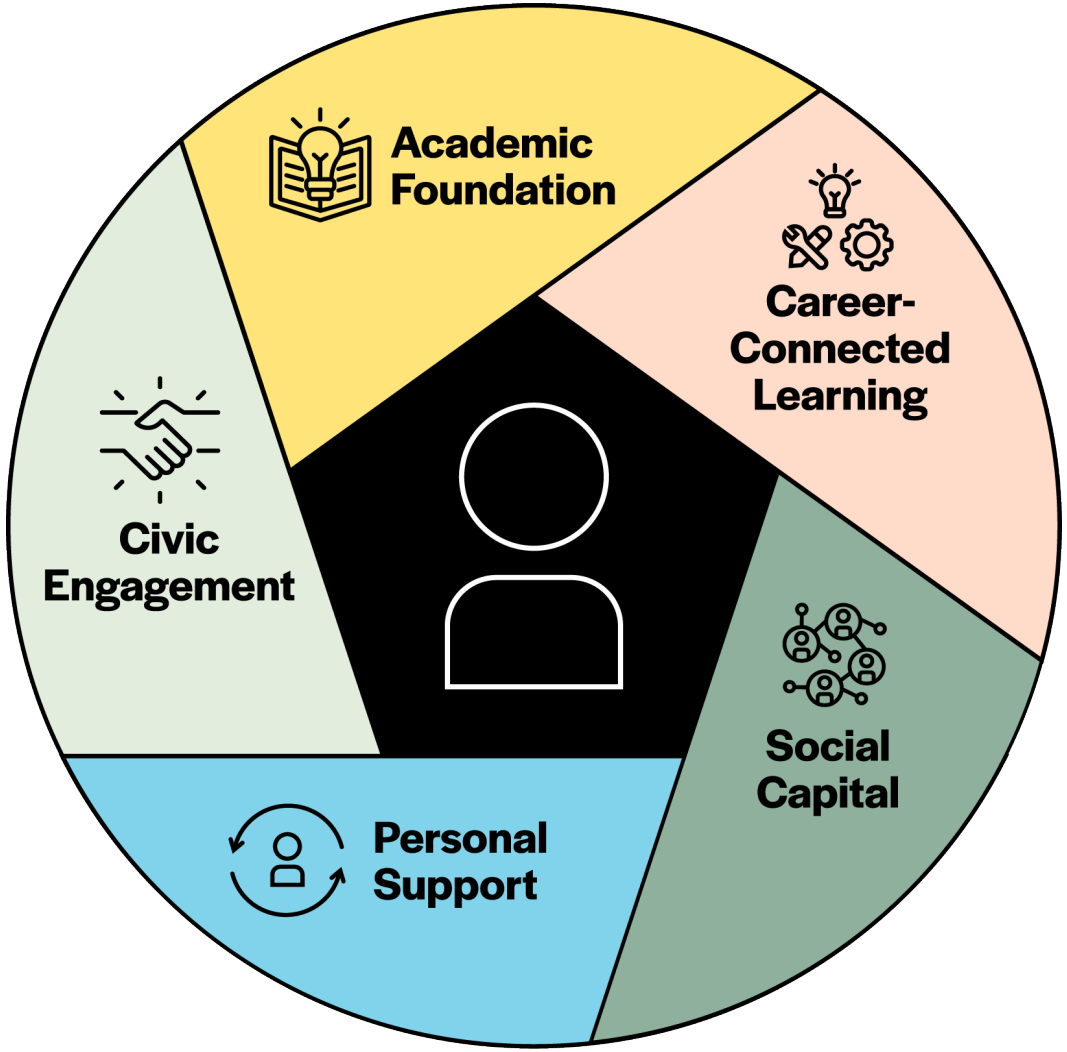
Graduates are unprepared.

High school and college graduates often lack the durable skills for entry-level positions.

OUR RESEARCH

How do we create academic, economic, and social mobility at scale?

For young people to thrive, they need access to the **five factors of mobility.**



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OUR RESEARCH

How do we create academic, economic, and social mobility at scale?

How to build **a strong academic foundation** (the first mobility factor).

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Unlocking Algebra

What the Data Tells Us About Helping Students Catch Up

Unlocking Insights from a Unique Data Set

teach to one roadmaps

A personalized, Tier 2 math solution that integrates with Tier 1 HQIM

Gathering Data **Every Day**

1. What skill did each student try to learn?
2. What predecessor skills did each student already understand when they tried to learn that new skill?
3. How did each student perform on their skill-level assessments?

THE CHALLENGE

Learning Algebra matters — for school, and for life. But many students struggle.

Passing Algebra by 9th grade opens opportunities.

These students are more likely to graduate high school, attend college, and earn higher salaries.[1]

But most students begin 9th grade behind grade level.

Only a quarter of 8th grade students are proficient in math – unprepared for the rigors of 9th grade Algebra.[2]

And for some students, failure is common.

Among students experiencing poverty, about 1 out of 5 fail.[3]

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Sources: 1: https://www.educationtoworkforce.org/indicators/successful-completion-algebra-i-9th-grade 2: 2024 NAEP https://nces.ed.gov/nationsreportcard/ 3: HSLS09 https://nces.ed.gov/surveys/hsls09/tables/alg1failed_E24.asp

So how can we help more students master Algebra I, especially when they begin behind?

Because Algebra builds on a large body of prior knowledge, it's hard to know how to support students at different levels of Algebra readiness.

OUR RESEARCH

To find out, we analyzed three years of data from students online learning platform as a supplement to their core Algebra I classes.

We wanted to know: Which Algebra I concepts and skills — learned in which order — led to the most success for students who started behind?

We examined data from Algebra I students using the New Classrooms online math tool, called *Teach to One Roadmaps,* as a supplement to their core classes. This data included:

More than

2,000

students in Algebra I classes

Making more than

125,000

attempts to demonstrate mastery

On

147

different algebra concepts and skills.

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OUR FINDINGS

1

Proficiency improves when students learn new Algebra-related concepts and skills, including those from prior grades.

As students gain more math concepts and skills overall—both from their current grade and previous ones—they perform better on state tests.

2

Learning new Algebra-related concepts and skills requires applying key predecessors.

When students tackle a new grade-level skill, knowing just a few key predecessors—tightly linked foundational knowledge—increases their chance of success.

3

Tier 2 intervention is most effective when students build on what they know.

In this approach, each student works on the most advanced Algebra-related concepts and skills, at any grade level, that they are best equipped to learn.

Our Findings in Detail

Algebra concepts and skills are introduced in every grade-level.

New Classrooms' online tool adopts 147 total skills for the full Algebra ladder. A diagnostic assesses how many of these skills students have already mastered, and students and/or their teachers can choose which unlearned concepts and skills they should focus on when using the program.

Algebra Ladder

All concepts and skills related to Algebra throughout a student's math education, both in Algebra I and prior grades.

Algebra I	52
Grade 8	28
Grade 7	19
Grade 6	21
Grade 5	11
Grade 4	11
Pre-4	5

Number of Algebra-related concepts and skills, by grade.

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If students start with gaps from prior years – far down the ladder — when do they start seeing success with grade-level content?

We isolated students who had state assessment data.

We looked at multiple grades – 5th through 9th graders – to expand our sample size to about 550 students. Students were from different schools in multiple states.

Did students meet their state's test expectations?

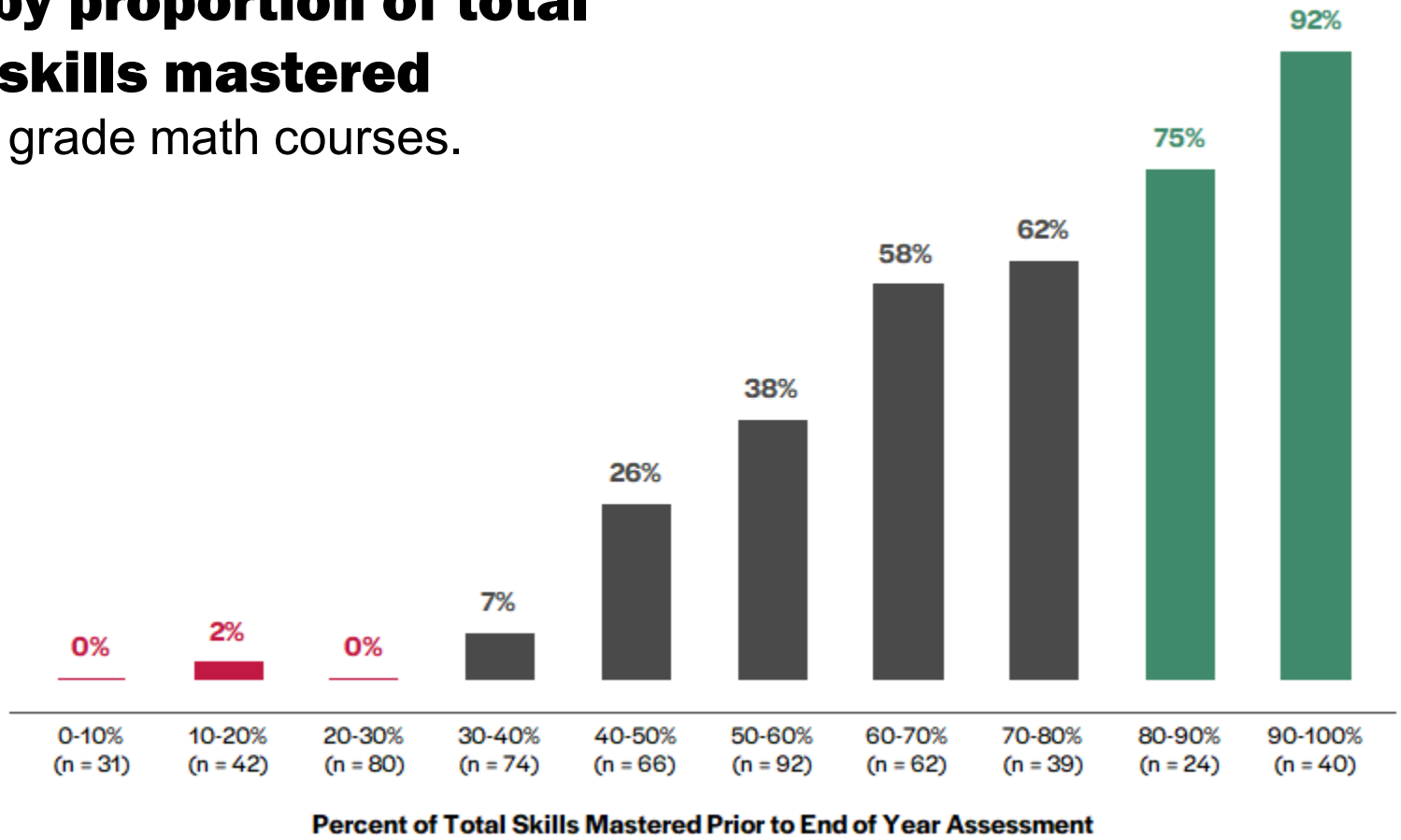
To compare performance across different states, we compared each students' raw test score to the score needed to meet their state's test expectations, which is typically a performance level of at least a 4 out of 5.

1 Acquiring concepts and skills matters.

Percent meeting state test expectations by proportion of total concepts and skills mastered

Students in 5th-9th grade math courses.

When students knew **less than one-third** of all concepts and skills, they almost never met grade level expectations.



Once students knew **around four-fifths** of all concepts and skills, they tended to meet expectations on their state tests.

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Note: Meeting Expectations is set differently for each state but typically requires earning a performance level of at least a Level 4 out of 5. In the plot above, percentages that are exactly equal to the upper bound of the bin (e.g., 10%, 20%, 30%, etc.) are included in the next highest bin.

Unfortunately, many students began Algebra I with few learned skills and concepts.

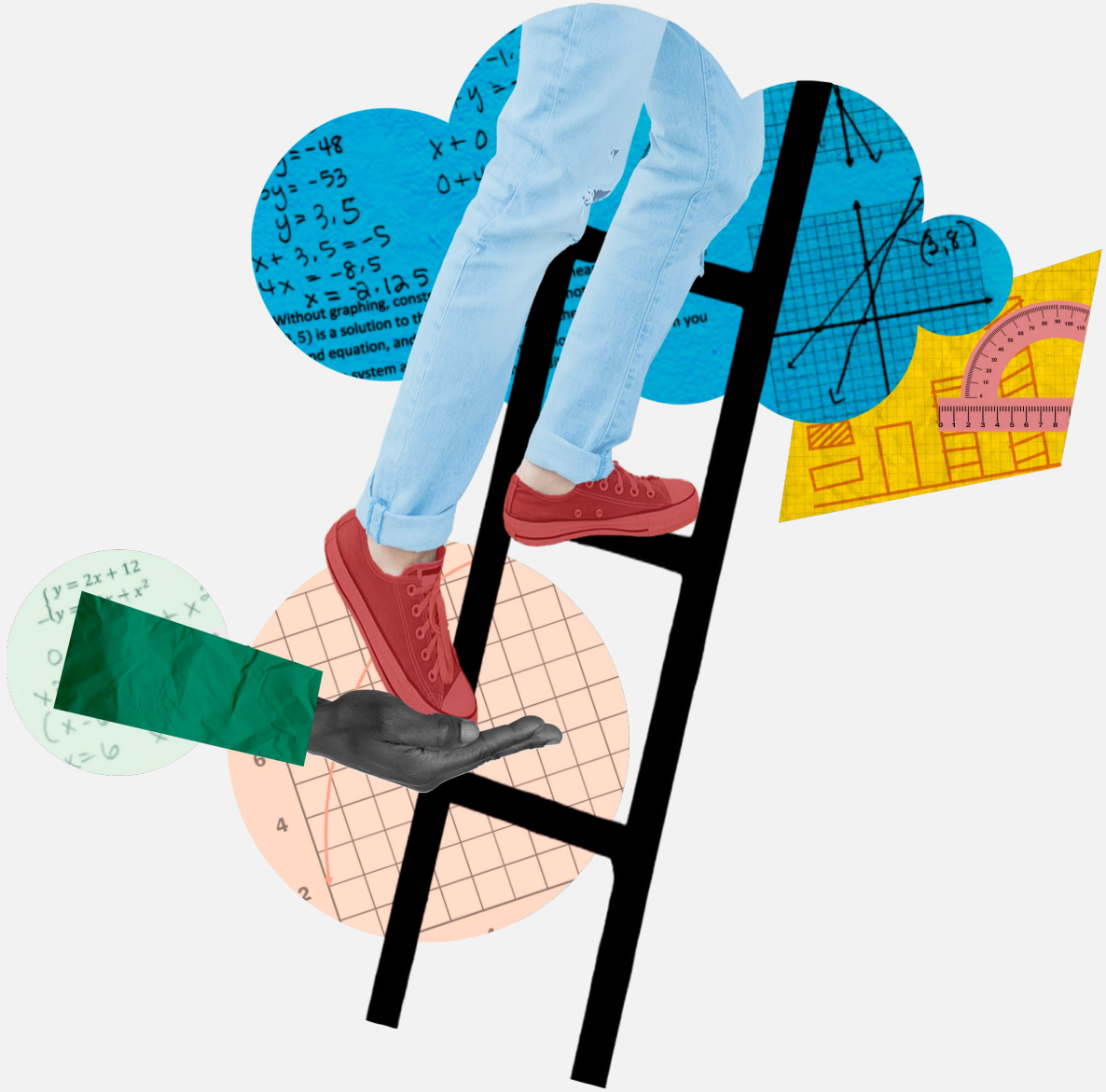
46%

Of students started Algebra I with no more than 32 skills.

Here's the challenge: Almost half of the students in our full sample started Algebra I knowing just one-third of all the pre-requisite concepts and skills.

That's a lot of ground to make up.

When students begin Algebra I behind, which skills and concepts from previous grades are most needed to move up the ladder?



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Predecessors

A typical Algebra concept draws on dozens of pieces of prior math knowledge. We call these **predecessors** — a specific concept and skill that is academically foundational to another concept and skill.

When students seek to learn the concept **Average Rate of Change**, which is introduced in 9th grade, it draws from:

8
8th Grade Predecessors,

11
7th Grade Predecessors,

13
6th Grade Predecessors,

9
5th Grade Predecessors, and

15
4th Grade Predecessors or Below.

If a student can't yet access this grade-level concept, **which predecessor is most likely to help?**

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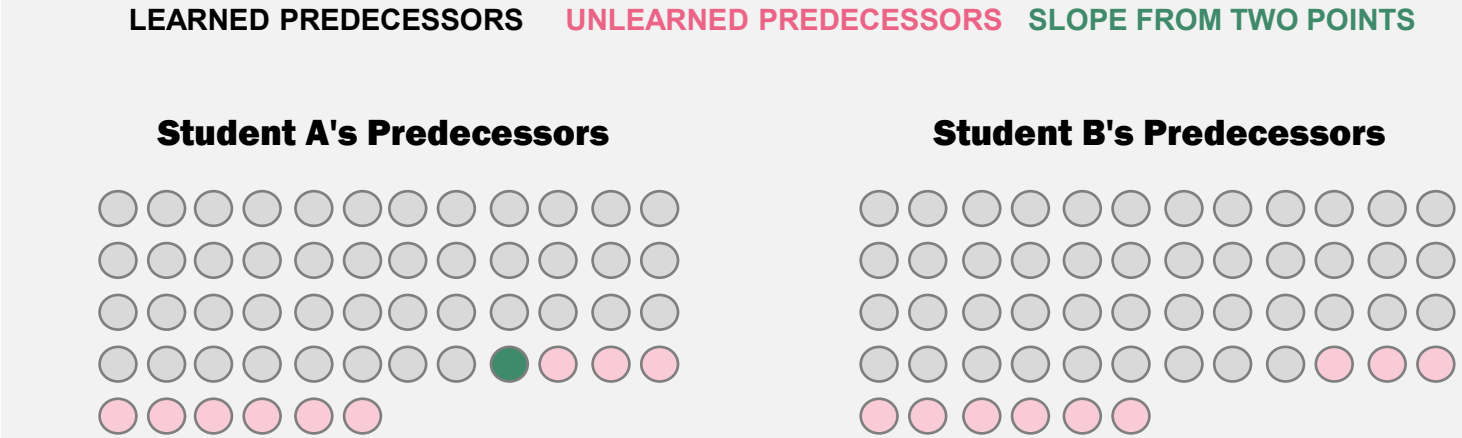
2 Some predecessors are more important than others.

Two students began the year at the same place and attempted to learn Average Rate of Change having already mastered the same number of predecessors. But one student had mastered the skill ***Constructing slope from two points*** and the other did not.

How much more likely is Student A to succeed?



We repeated with all predecessors and flagged the three that improved this success the most as **key predecessors**.

Note: Key predecessors identified with separate linear probability models for each skill-predecessor combination on the algebra ladder controlling for the total number predecessors mastered, the number BOY skills, the number of prior attempts at that skill, and for each predecessor, a binary indicator if that predecessor was mastered. The predecessors linked to the largest estimate of the latter became the key predecessors for that skill.

2 For students who start behind, knowing a few key predecessors sets them up for the most success.

Few predecessors, no key predecessors

When students knew fewer than half of the predecessors and no key predecessors, their success rate on a new Algebra I concept and skill was:

13%

Most predecessors, few key predecessors

When students knew at least 80% of the predecessors but fewer than half of the key predecessors, their success rate was:

31%

Most predecessors, all key predecessors

When students knew at least 80% of the predecessors and all the key predecessors, their success rate was:

58%

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Note: Students who started off behind are those who began the year with 75 or fewer concepts and skills. There were 1303 attempts made when students had few predecessors and no key predecessors. There were 1627 attempts made when students had at least 80% of the predecessors but less than half of the key predecessors. There were 5315 attempts made when students had mastered all key predecessors. Note that attempts where all key predecessors were mastered also tend to have more predecessors mastered overall (average = 98% predecessor mastery rate), but these results were similar when we looked only at attempts where all key predecessors were mastered but 90% or fewer of all predecessors were mastered: the success rate was 66% and N = 254

How can focusing on key predecessors support students who start Algebra I behind?

To answer this, we took all students who started the year behind—the ones who started Algebra with one-third of the pre-grade skills, on average—and simulated what would happen during a school year with different Tier 2 intervention strategies over a year:

Common Blanket Approaches

Start at the Bottom

Students are labeled as being at a specific grade – e.g., “at a 6th grade level” – and begin working on all the Algebra skills at that grade-level before moving on.

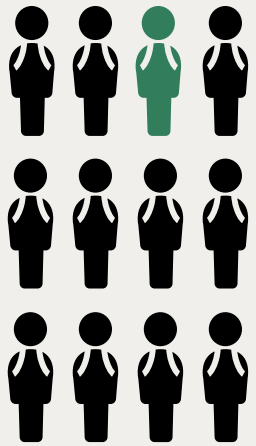
Grade-Level Only

Students work *only* on concepts and skills introduced in ninth grade Algebra I.

Individualized Approach

Students work on the most challenging concept and skill that they're ready to learn. They work on problems where they know the most key predecessors. All content is new to them.

Our simulations were based on actual students' individualized records of success and failure with different types of skills.



We used each student's personal record of success and failures to create an **individualized** prediction of their chance of succeeding on any given skill. This prediction is based on the how many skills the student begins the year with, how many key predecessors the student has already mastered, and the typical relationships between these two factors and one's chance of success.

Then we simulated what would happen if each student made 50 attempts during a school year, tackling 1-2 new concepts and skills per week in the school year, using each of the three different strategies.

3 Over time, students learn most from tailored practice.

Simulated Student Success with Different Intervention Approaches

Approach	Success Rate On Attempts	Total Concepts and Skills Gained
Start at the Bottom **Students work only at the grade level where they're missing most prior concepts and skills.** They work straight through all concepts and skills in that grade and repeat some content they've already covered.	45%	12
Grade-Level Only **Students work only on concepts and skills introduced in Algebra I.** They work straight through the Algebra I curriculum. Regardless of whether they master a concept and skill, they move along to the next. Nearly all content is new to them.	28%	14
Individualized **Students work on the most advanced concept and skill that they're ready to learn.** First, the simulation identifies the concepts and skills where students had mastered the most key predecessors, then assigns problems from the highest possible grade level. All content is new.	50%	25

When students work at the sweet spot between challenge and readiness, they learn the most Algebra over time.

When students have unfinished learning, it doesn't help students to practice all content from prior grades, nor does it help them to slog only through grade-level work if they're missing key predecessors.

Recommendations

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Teachers and specialists need to work within a system of instructional coherence

Coherence means that all pieces of the school's instructional program—curriculum, materials, interventions, and assessments—work together to advance the same set of grade-level expectations. Students know exactly what to expect and how to succeed.

Yet this level of instructional coherence is rare. In many schools, Tier 2 materials only loosely connect to core classes, and assessments measure different things in each tier.

How can we develop systems that help teachers and specialists to work together coherently to support students in Algebra I?

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For States:

Create the Conditions for Coherent Tier 1 and Tier 2 Experiences

There's a lot of focus on rigorous Tier 1 curriculum, and many states set adoption criteria for high-quality instructional materials. However, few set clear parameters for Tier 2 experiences. State leaders can use Tier 1 curriculum lists to advocate for coherent interventions (e.g., Tier 1 materials must be adopted with appropriate supports) or add a dedicated Tier 2 list (e.g., solutions that are aligned to Tier 1 curricula).

Alignment doesn't mean that Tier 1 and 2 materials are from the same provider, or that students work only on grade-level content in both settings. Instead, Tier 2 should address unfinished learning and build directly towards grade-level content.

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For School Systems:

Adopt Rigorous Tier 2 Solutions

School systems often use online learning products as one part of their Tier 2 strategy. But many popular platforms take a start at the bottom approach, providing practice that is too easy or unrelated to the lesson at hand. Others take a grade-level only approach that aligns to Tier 1 instruction but does little to address unfinished learning on key predecessor concepts and skills.

When purchasing a Tier 2 solution, it's important for system leaders to understand how the platform diagnoses student readiness and recommends practice tasks.

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For Schools:

Ensure Tier 1 and Tier 2 Work Together

School leaders must set clear expectations that the **purpose of Tier 2 is preparing students for core instruction**. That may mean adjusting the schedule, so core teachers and Tier 2 intervention specialists have time to work together, setting aside more time for individualized support in core math instruction, or creating double blocks (80-90 minutes) for Algebra I.

Action & Next Steps

Audience Q&A

Stay Connected

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New Classrooms

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