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Students Take an Alternative Route to Algebra 1 Success

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Too many of the nation's 14-year-olds inadvertently narrow their college options before they've even settled into high school. They do so, in either grade 8 or grade 9, by failing the gateway course for all college-preparatory high school mathematics: algebra 1. Worse yet, many of those who try to get through the gate a second time fail again.

"When a student fails algebra 1, it's common practice to have the student repeat the course—often with the same textbook and the same teacher," says Mardi Gale, a senior research associate at WestEd. "But studies have shown that repeating algebra 1 is rarely successful because it doesn't address the underlying reasons for students failing the course in the first place."

Key among these reasons, according to Gale, is that K–12 mathematics instruction often focuses too much on following computation rules to solve problems and not enough on understanding how the mathematics work. "Instead of helping students build number sense—the conceptual understanding of numbers and their relationships—math teachers [who have repeaters in their class] tend to continue emphasizing the same computation procedures and shortcuts that students failed to grasp the first time around," she says.

Gale is primary author of the Aim for Algebra™ intervention program, a supplemental curriculum designed to help high school students prepare for success in algebra by revisiting and building a solid understanding of challenging math concepts introduced during elementary and middle school but which many have failed to learn deeply enough to retain.

Developed as a series of 12 modules that teachers can use in high school classes, the Aim for Algebra curriculum has shown impressive results—not only with low-performing secondary students but also with algebra and pre-algebra classes in the middle grades. In randomized controlled studies, Aim for Algebra demonstrated statistically significant gains in student achievement. In many cases students made double-digit improvements between pre- and post-tests in just six weeks.

Focusing on Understanding

The Aim for Algebra curriculum modules, published by It's About Time, focus on common trouble spots for students—such as exponents, the coordinate plane, and signed number operations—and are designed to be flexible so teachers can use them as needed to supplement comprehensive mathematics textbooks. In some Colorado school districts, for example, teachers used the modules beginning in sixth grade to help students develop their understanding of math concepts and then added other parts of the program as students advanced through the eighth grade.

San Diego City schools used the modules in after-school programs where strugling students receive individual tutoring. High schools in Tracy, California, have used Aim for Algebra with students needing math support and with non-native speakers.

Each Aim for Algebra Lesson Contains Three Sections

Launch, the warm-up section, emphasizes ways to connect the new content to prior learning. Rather than teach students shortcuts that can distort mathematical problem-solving, Aim for Algebra scaffolds skills within and across topics so students can confidently draw on experience when confronting new material. For example, whereas teachers traditionally show students a shortcut method of cross—multiplying to find the missing part of a proportion, Aim for Algebra emphasizes the broader concept of equivalent ratios so students will understand factoring, common denominators, and other fundamental principles they will return to again and again in math.

Or, instead of teaching students FOIL, a common shortcut for multiplying binomials in order of the First terms, the Outer terms, the Inner terms, and then the Last terms, Aim for Algebra ensures that students understand the distributive property so they can use it with many different applications.

"If you only teach the computation rule," Gale says, "students get confused because they're not sure what or why they are multiplying. If students understand the relationships between numbers, they can work at the conceptual level instead of just following the rules. There are steps to follow, but that's different from memorizing a rule that's not connected to the mathematics."

Explore choreographs the activities of the lesson, engaging students in rich discussions of math ideas. Like the Japanese math lessons lauded in the Third International Mathematics and Science Study (TIMSS), Aim for Algebra focuses on students' active construction of knowledge. Students discuss and complete problem-solving tasks independently, in pairs, and with the whole class. While students work on tasks, the teacher circulates and asks probing questions to ensure they are on the right track and not just offering "pat" responses. Recognizing that there may be a variety of correct ways to represent a solution, the teacher avoids telling or showing students how to solve the problems so they can learn to do the thinking themselves.

Summarize ensures that students can connect their experiences to the stated purpose of the lesson and then extend their understanding by applying the mathematical concepts they've learned to new problems, through discussion and homework practice.

Talking About Mathematics to Deepen Understanding

Because the curriculum emphasizes collaborative group work on problems and classroom conversations about math, students get robust practice sharing their ideas on how to go about solving a problem and hearing others' explanations. Aim for Algebra also encourages students to explore graphic representations of mathematics concepts. Rather than primarily following directions and filling out worksheets of practice problems, students are urged to work collaboratively to explore and defend their thinking in pairs or small groups and expand on their problem-solving strategies. In this way, the curriculum aligns with the Common Core State Standards' emphasis on learning to construct viable arguments and critique the work of others.

"I implemented the Rational Numbers module, and my classroom became a lot more student

driven," a participating teacher explained in a feedback survey on Aim for Algebra professional development. "Group work and presenting/discussing ideas was a norm rather than direct teaching." English language learners "really took to the drawing of fractions to demonstrate equivalence and operations. It provided the concept that they did not get in prior years."

Aim for Algebra teaches students to use and understand the precise language of mathematics, another emphasis of the Common Core State Standards for Mathematical Practice. The goal is to help students develop knowledge they can apply in the future, not just memorize it for a test. A strong academic vocabulary supports students to apply math principles in various contexts and helps to develop understanding. For example, in the Rational Numbers module, Aim for Algebra encourages students and teachers to translate decimal numbers precisely to emphasize the place value of the quantities. We want students to consider the number "0.425" and say "four hundred twenty-five thousandths" not "point four, two, five." Using the precise language reinforces the understanding of place value and relative value of the decimal number.

Making the Curriculum Work for Teachers

WestEd provides extensive teacher professional development in the use of Aim for Algebra, including working to build the knowledge and skills required to structure and model a lesson, anticipate the misconceptions and questions students are likely to have, and guide student reflections that will promote retention of new ideas. In addition, the facilitator's guide for each module lays out a complete lesson plan that links learning objectives to learning activities, which in turn are linked to assessments.

Gale says teachers who effectively implement Aim for Algebra have marveled at how well their students carry over understanding of vocabulary and number sense to topics not covered in the curriculum. Teachers often notice an increase in the understanding and confidence exhibited by students in regular math classes.

Despite teachers' enthusiasm for the program, some have not been able to continue using it because of restrictive district pacing guides that expect all teachers to instruct and assess students in the same way and at the same rate. Gale says one of the lessons of Aim for Algebra is that successful interventions require flexibility. Not all students have the same gaps in learning, and not all will learn at the same pace. Teachers can still meet accountability goals by using Aim for Algebra, and administrators must support their efforts to offer deeper instruction that deviates from district-level plans.

Aim for Algebra also supports an approach to teaching mathematics that addresses the intent and goals of the Common Core State Standards and the CC Standards for Mathematical Practice, which 46 states are committed to implementing. "The program encourages mathematical discourse, tasks with high cognitive demand, and a focus on teaching key concepts for deeper understanding," Gale says, "all of which contribute to developing mathematically literate students who can meet the demands of the 21st century."

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